CLAVICLE HOOK PLATE OUTCOMES IN LATERAL CLAVICLE FRACTURES

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ABSTRACT

Background: Clavicle fracture is a common traumatic injury of the shoulder girdle because of the subcutaneous position of the clavicle. The clavicle hook plate is designed to maintain the acromio-clavicular joint biomechanics, and this allows early mobilization and avoids the need for reconstruction of the coraco-clavicular ligaments.

Aim of the study: The aim of this study was to assess outcomes and complications of clavicle hook plate for lateral clavicle fractures.

Patients and methods: This study was conducted on twelve patients with distal clavicle fracture IV in emergency department of Zagazig university hospitals and some other hospitals, ten of them were Neer type II and two were Neer type V. Patients with Neer type I, III, and IV, patients with open fractures, and neurovascular injury, and patients with incomplete evaluation at final follow up were excluded. They have been operated using clavicle hook. Post operative clinical evaluation was performed weekly for 2 weeks, then every 2 weeks till the end of third month, then month Radiological evaluation consisted of shoulder AP radiograph performed monthly. Postoperative complications or failure was recorded.

Results: The mean constant score for the cases was 94.583 + 4.562. The mean union period was approximately 13.5 weeks, 5 cases reported different complications including non-union, infection, AC arthritis, adhesive capsulitis and impingement, the constant score was affected significantly only in the two cases complicated by non-union and adhesive capsulitis.

Conclusion: Hook plate fixation is a good primary treatment for the unstable 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.

Keywords: Clavicle Hook Plate, Lateral Clavicle Fractures.

I. INTRODUCTION:

Clavicle fracture is a common traumatic injury of the shoulder girdle because of the subcutaneous position of the clavicle (1).

Fractures of the distal clavicle account for approximately 10% to 30% of all clavicle fractures (2).

Lateral clavicle fractures (LCF) are classified according to Neer based on their relation to the coracoclavicular ligaments. Neer types I, III and IV are considered to be stable fractures and are generally treated conservatively. The unstable Neer type II and V fractures account for approximately 10–52% of LCF. Surgical management is recommended for these unstable LCF, as non-operative treatment results in a 22–50% non-union rate (2).
Neer type II fractures are unstable due to the detachment of the coracoclavicular ligaments from the medial fragment. Neer type V fractures have a comminuted character, with only an inferior fragment remaining attached to the coracoclavicular ligament (3).

Management of distal clavicle fractures is often challenging because of the difficulty in distinguishing subtle variations in the fracture pattern that may indicate fracture instability. Stable fracture patterns generally heal uneventfully with nonsurgical management, but unstable fracture patterns are often associated with longer time to union and notable nonunion rates. Because of the concern that nonsurgical management may result in nonunion, primary surgical management has been recommended for certain distal clavicle fracture patterns (2).

Several methods of internal fixation have previously been reported including tension band wiring using Kirschner wire, Knowles pin fixation and plate fixation. However, the complication rate from wire fixation is unacceptably high. Kirschner wire fixation sometimes results in migration or break of the wire or correction failure of the fracture. For Neer type II fractures, plate fixation has many advantages because the distal fragment is small. The AO clavicle hook-plate was introduced in 1997 in Europe and in 2002 in Asia. The design of this plate was improved to prevent acromial fracture and a better outcome was expected (4).

We aimed at this study to assess outcomes and complications of clavicle hook plate for lateral clavicle fractures.

II. PATIENTS AND METHODS:

2.1. This study was conducted on twelve patients with distal clavicle fracture IV in emergency department of Zagazig university hospitals and some other hospitals, ten of them were Neer type II and two were Neer type V. Patients with Neer type I, III, and IV, patients with open fractures, and neurovascular injury, and patients with incomplete evaluation at final follow up were excluded.

The study was recruited on 12 patients. Female represented half of the studied patients. Age ranged from 18 to 50 years with mean 32.083 years. About 42% of patients worked as professional and semiprofessional. After obtaining the approval of the institutional review board (IRB) of Zagazig University.

2.2. A consent form approved by the committee of human rights in research in Zagazig University was obtained from each participant before the study initiation.

2.3. The patients who met the inclusion criteria and were suitable candidates for the study have been subjected to

A-Preoperative evaluation:
1. History:
A careful detailed history was taken and included the age, gender, affected side, and mechanism of injury.

2. Clinical evaluation:

General examination:
Patients were examined to detect the presence of any medical disorders and to determine their general condition. Also, a thorough examination of polytrauma patients was done in order not to miss any associated injury.

All the patients with associated injuries were evaluated and treated.

One patient had distal radius fracture was operated by volar plate, another patient had gelliazi fracture dislocation were treated by ORIF, another patient had intracranial hemorrhage treated by neurosurgery then transferred to orthopedic department, another patient had lung contusion treated conservatively by cardio-thoracic surgery department.

Local examination
Local assessment included careful inspection for deformity, bruises or abrasions, and associated injuries

3. Radiological evaluation
Figure (1): X-ray showing lateral end clavicle fracture.

Radiological examination consisted of AP radiograph of both shoulders for detailed evaluation of the fracture pattern and displacement and the arthritic changes and osseous lesions within the AC joint.

B- Operative technique:
• Anesthesia: General Anesthesia was used for ten patients and regional block (bilateral superficial cervical block) was used with in patients.
• Position: Beach-chair position

Figure (2): Beach chair position.

• Approach:
  - Superior approach was used for this procedure.

Figure (3): Superior approach to the clavicle.

• Surgical Procedure:
The surgical technique consisted of application of basic reduction and plating methods, following the operative procedure as advised by the AO.
  - acromio-clavicular joint was identified by a sterile gauge needle.
- Reduction was performed indirectly of a distal clavicle fracture by the plate.
- After good reduction, temporary fixation with a K-wire was performed.
- A small incision was made at the posterior aspect of the acromio-clavicular joint to allow placement of the hook under the acromion.
- The hook plate was applied to the fracture, with minimum of 3 screws in the proximal fragment.
- Correct placement of the hook posteriorly under the acromion helped in reduction and prevented rotator cuff impingement.
- The hook portion position under the acromion aided to resists medial and downward translation of the arm.
- Closure of the deltotrapezialmyofascia layer and the skin subcutaneous layer in two-layer closure over the plate.

**Figure (4):** Sterile gauge needle in acromio-clavicular joint and temporary fixation by k-wire.

**Figure (5):** Indirect reduction by the plate.

There are a number of intraoperative maneuvers that helped avoid over reduction including:

- Selecting a hook depth that is appropriate for each case.
- In three cases it was necessary to contour the hook or the shaft of the plate to optimize plate placement, as anatomy was quite variable.
• Excessive downward pressure on the clavicle was avoided as this could result in over-reduction.

• Resection of superior bony prominence of the distal clavicle to provide a flat upper surface for plate placement.

C-Postoperative evaluation:

1. Clinical (wound care): The dressing was changed two days after surgery and showers were allowed and a light dressing may be applied, and the sutures or staples have been removed after two weeks.

2. Radiological: Consist of shoulder AP radiograph to ensure that plate and screws are at optimal position, and all are extra-articular.

![Shoulder AP radiograph for post-operative hook plate fixation.]

D-Follow up evaluation:

1. Clinical: Clinical evaluation was performed weekly for 2 weeks, then every 2 weeks till the end of third month, then monthly till the end of the follow-up.

• Constant-Merley -score (CS) (6) was completed at 3rd and 6th month. This score was compared to the other healthy shoulder.

• The Constant-Murley score (CS) is a 100-points scale composed of a number of parameters.

• The Constant-Murley score was introduced to determine the function after the treatment of a shoulder injury. The score is divided into four subscales: pain (15 points), activities of daily living (20 points), strength (25 points) and range of motion (40 points) including forward elevation, abduction, external rotation and internal rotation of the shoulder. A higher score indicates higher quality of shoulder function.

2. Radiological

Radiological evaluation consists of shoulder AP radiograph performed monthly.

Postoperative complications or failure was recorded: implant breakage, secondary displacement, infection, clavicle erosion, or early AC arthropathy.

E- After care:

Sling support was provided until the patient is comfortable to start shoulder use, or radiographs show early evidence of fracture healing.

Once these goals were achieved, rehabilitative exercises can be started to restore strength, function and range of motion.

These phases are followed after surgery:

- Temporary immobilization
- Passive/assisted range of motion
- Active range of motion
- Progressive resistance exercises

Usually, immobilization was continued for 1-2 weeks for wound healing purposes and until pain subsides. The use of the sling was gradually decreased. After that gentle range of motion exercises usually follows.

Non-weight-bearing of the affected limb was continued for about 6 weeks or until clinical and radiographic evidence of progressive healing.

Resistance exercises was generally started at 6 weeks. Isometric exercises may begin earlier, depending on the injury and patient symptoms.

III. RESULTS:

Results were evaluated both clinically by constant score and radiologically by serial x-ray. The mean constant score in this study was 94.583 ranging from 85 to 9 (Table 1).

Radiologically, all patients showed fracture union except one patient had the fracture non-united. Eleven patients had their fracture united within period ranged from 7 to 30 weeks with mean 13.727 weeks (Table 2).

About 58% of the patients had no postoperative complications. Five patients were complicated in the form of either non-union (8.3%), AC arthritis (8.3%), adhesive capsulitis (8.3%), infection (8.3%) and impingement (8.3%) (Table 3, Figure 7)

There was a statistically non-significant correlation between time till operation and constant score (Table 4).

Plate removal:

Hardware removal is usually optional for those with conventional plates, however, to regain terminal shoulder flexion and abduction a large percentage of individuals with hook plate fixation are anticipated to require removal of the plate. This is performed as early as possible just when the signs of full fracture site healing and bone consolidation.

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<th>Constant score</th>
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<td>Mean ± SD</td>
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<tr>
<td>Range</td>
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<th>Table 2: Distribution of the studied patients according to time till union</th>
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<td>Time till union                  N=12 (%)</td>
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<tr>
<td>Mean ± SD                        13.727 ± 6.482</td>
</tr>
<tr>
<td>Range                            7 – 30</td>
</tr>
<tr>
<td>Union:</td>
</tr>
<tr>
<td>No                               1 (8.3)</td>
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<tr>
<td>Yes                              11 (91.7)</td>
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<th>Table 3: Distribution of the studied patients according to postoperative complications</th>
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<td>Complications:                        N=12 (%)</td>
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<tr>
<td>None                                  7 (58.3)</td>
</tr>
<tr>
<td>Non-union                             1 (8.3)</td>
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<tr>
<td>AC arthritis                          1 (8.3)</td>
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Adhesive capsulitis: 1 (8.3)
Impingement: 1 (8.3)
Infection: 1 (8.3)

Figure (7): Pie chart showing distribution of the studied patients according to presence and type of postoperative complications.

Table (4): correlation between time till operation and time till union and constant score:

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<tr>
<td>Time till operation</td>
<td></td>
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<tr>
<td>Time till union</td>
<td>0.37</td>
<td>0.263</td>
</tr>
<tr>
<td>Constant score</td>
<td>-0.191</td>
<td>0.551</td>
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Figure (8): Thirty year old Female, doctor, fromdyarbnegm had road traffic accident and developed lateral third left clavicular fracture. With associated distal radius fracture. No pre-existing medical disorders and no previous operations. The surgery was done on the same day of trauma, Allman Group II, Neer Type II.A)X-ray showing fracture distal end
clavicle, B) X-ray showing day 1 post operative fixation with hook plate, C) X-ray showing 9 months post operative, D) x-ray after removal of the plate.

IV. DISCUSSION:

The first decision to make in a patient with established radial nerve palsy is whether to attempt late...
In our study one case (8.3%) encountered deep infection treated by early debridement but none of the cases developed fixation failure.

Several long-term complications associated with the lateral clavicular fracture have also been described in relation to the use of hook plate. These are ACJ arthrosis and extra articular ossifications. Several authors discourage use of this plate due to the proximity of this plate to the ACJ, but the plate does not violate the ACJ when placed correctly (12).

ACJ arthrosis and extra articular ossification have been described in all types of lateral clavicle fractures in studies where there was longer term followup with different treatment modalities.

Nordqvist et al. described a cohort of conservatively treated lateral clavicle fractures with a mean follow up of 15 years. They reported seven ACJ arthrosis in 89 patients. Five of these occurred after a type I fracture, one after a type II and one after a type 3 fracture. Extra articular ossification was observed in eight cases (13).

Robinson et al described a prevalence of 9% - 15% of ACJ arthrosis in patients with lateral clavicle fractures treated with conservative treatment (14).

Flinkkila et al described 63 patients with displaced lateral clavicula fractures treated with the clavicle hook plate. 31 patients (50%) were followed up with a mean follow up of 3.6 years. Ten of 31 followed up patients (32%) had mild asymptomatic ACJ arthrosis (15).

One of our cases developed acromio-clavicular joint arthrosis and it was asymptomatic, but none of them developed extra articular ossification. Flinkkilä et al made comparative study on 39 unstable fractures of the distal clavicle (Neer 2). Kirschner wire (K-wire) fixation was used in 22 cases and a clavicular hook plate in 17, he found that Complications commonly occurred with K-wires, which migrated in twelve cases, resulting in loss of reduction in seven and infection in three, and two cases of non-union. In the clavicular hook plate group, there was one complication, a fracture of the clavicle, and two cases of non-union. and he concluded that both methods reduced shoulder symptoms and function restored to an adequate level, but complications were unacceptably frequent with K-wires. And they recommended the use of hook plate in unstable distal clavicular fractures

Muramatsu et al studied 50 patients with unstable lateral end clavicle treated with hook plate, the mean constant score was 89 points at the final follow-up all his cases were united, but his concern was about hook migration and to avoid this complication he recommended removal of the plate at 6 months after fracture full union

Bhangal et al also treated 13 patients with lateral clavicular fracture with hook plate and the mean constant score was 92 compared to 93.5 at non fractured side and they concluded that the use of AO hook plate increases union rate with a good return of function.

Tiren et al treated 28 patients with hook plate, the mean constant score was 97.2 and they concluded that the use of hook plate in treatment of patients with displaced lateral clavicle fractures has produced good short term and mid-term results, and using this plate may cause impingement and subacromial osteolysis, without leading to functional impairment

V. CONCLUSION:

We conclude that clavicle hook plate fixation is a good primary treatment for the unstable 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.

Part of the treated patients do develop symptoms of impingement due to a mismatch between patient anatomy and the plate, one of the reasons the plate has to be removed after fracture consolidation. Midterm follow up shows no additional damage done to the surrounding structures that can be addressed to the use of this plate. In summary, the AO hook plate results in a good return of function and a high union rate. We advocate contouring the plate at the time of the surgery and removal of the plate after fracture consolidation.

This is a small series, and a larger number of patients are required to lend statistical support to the merits of this technique. Nevertheless, the high union rates and the excellent short-to-medium term function scores are very encouraging, and the use of the AO hook plate is now our preferred method of management of the displaced lateral third clavicle fractures.
Conflict of Interest: No conflict of interest.

REFERENCES