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Hook plate versus locking plate: Functional outcome of Neer's type ii lateral end clavicle fractures

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Abstract

Background: Clavicular fractures are common and typically occur in young patients, leading to a burden for this active population. Although distal clavicle fractures represent only 25% of all clavicle fracture cases, they constitute 30–45% of cases of non-union, hence surgical intervention. Therefore recent literature suggests surgical management either with Clavicle Hook Plate or Clavicle distal locking plate for all Neer's Type II distal clavicle fractures. The purpose the study is to compare the results of this fracture management with Clavicle Hook Plate and Clavicle distal locking plate.

Aim: The aim of this study was to compare the functional outcome of clavicle hook plates versus distal clavicle locking plate for the treatment of Neer type II distal clavicle fractures.

Materials and methods: Totally 39 patients (18 retrospective cases and 21 prospective cases) with Neer Type II lateral end clavicle fracture were included in the study. A prospective study was done between July 2019 and June 2021, with a mean follow up of 18.5 months of 21 patients with Neer type II lateral clavicle fractures, treated with clavicle hook plate and Hook plate alternatively. Similarly retrospective analysis was also studied with a mean follow up of 24 months of 18 consecutive patients.

Results: Among the 39 fractures, the average Constant-Murley shoulder joint function score at 3 months was 89.87(range 84.2-93.3) and at 6 months was 94.6 (range 88.4-96.1) for the distal clavicle locking plates, and for the clavicle Hook plates 86.3 (range 80.8-93.5) at 3months and 92.5 (range 86.7-94.3) at 6 months follow-up (P-value < 0.05). The results showed that those patients who underwent surgery with clavicle locking plate had improved Constant-Murley shoulder joint function score as compared to hook plate patients at 6 months follow up in both prospective and retrospective studies.

Conclusion: Our study concludes that clavicular hook plate is better option in compare with distal clavicle locking plate for the treatment of Neer type II distal clavicle fractures in terms of improved Constant-Murley shoulder joint function score.

Keywords: Lateral end clavicle fracture, locking plates, hook plate, functional outcome

Introduction

Fractures of the clavicle are common injuries of young patients, accounting for about 3% of all injuries and leads to a burden for this active productive population [1]. They are often caused by either a direct blow to the anterior chest wall or by a fall on the outstretched hand. The commonest site of fracture in clavicle is the mid shaft followed by the lateral end (Neer's Classification), which accounts for about 25% of all the clavicle fractures [2, 3]. The lateral fractured fragment is small and hence, it is difficult to get an anatomical reduction and also poses problems in its fixation, which results in instability, malunion, non-union, implant failure of the lateral clavicle fractures [4].

Strategies for the treatment of clavicular fractures include coracoclavicular fixation (sutures such as a tight rope or endobutton and screw) [5, 6, 7] and fracture fixation devices (clavicular hook plate, clavicular locking plate and screw with lateral extension, tension band wiring and trans acromial pinning with Kirschner wires fixation [8-13]. Clavicular hook plates and clavicular locking plates are two common internal fixation methods for treating Neer type II clavicular fractures. However, the efficacy and safety of clavicular hook plates and clavicular locking plates in the treatment of clavicular fractures remains controversial.

We performed a prospective and retrospective study & validated the functional outcome based on Constant-Murley scores that compared the clinical efficacy and safety of clavicular hook plates and clavicular locking plates for the treatment of Neer type II distal clavicle fractures.

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Materials and Methods

This study was designed and conducted at S.V. Medical College & Hospital, Tirupati in both prospective and retrospective ways between July 2017 and June 2021. The patients who were admitted with clavicle fracture were included in the study subjected to the following inclusion criteria: (1) Neer type II fractures; (2) fresh and unilateral fractures; (3) no accompanying injury; (4) normal shoulder function before injury; and (5) at least 12-month follow-up. Patients lost to postoperative follow-up, associated acromioclavicular joint dislocation, pathologic fractures and previous surgery on the affected clavicle or shoulder, and incomplete data were excluded. According to these criteria, 39 patients were included in the study (28 men and 11 women). Retrospective study was considered from July 2017 to June 2019 with 13 men and 5 women and Prospective study included 15 men and 6 women, between July 2019 and June 2021period. Alternative pattern of implant selection was done for patient in the prospective study. All the surgeries were performed under general anaesthesia and in the supine position with a roll of towel in between the scapula to retract the clavicle. The head of the patient was turned towards the opposite side to get a clear view of the operating site. A horizontal incision was taken over the superior clavicle, centring the fracture, followed by subcutaneous dissection taking care of the supraclavicular nerves. Division of platysma exposed the clavicle. The reduction was achieved and maintained by a temporary Kirchner wire fixation and later with either locking or hook plates without coracoclavicular ligament augmentation [14].

Surgical Technique: The clavicle hook plate used in this study is a pre-contoured stainless steel, 3.5mm locking plate with a wider anterolateral end and a lateral extension into a hook which is placed below the acromion. These plates are available (precontoured in left and right) with 6 or 8 holes and the hook depth is variable between 15 and 18 mm's (Figure 2(a)). The Clavicle Hook Plate Surgical Procedure consisted of application 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 anesthesia or intersclene block with the arm on the affected side freely moveable. A lazy curved skin incision, placed coronally, centring the fracture was given in all the cases. Skin flaps were elevated, taking extra care to keep the flap as thick as possible to ensure its viability. The fracture fragments were neatly dissected with minimum soft tissue periosteal elevation and the fragments were reduced carefully and were temporarily fixed with smooth K-wires. Without opening the AC joint, it was located under image intensifier and the soft tissue dorsal to the AC joint to allow was slit just enough insertion of the hook of the plate. First the hook the plate hook depth is manoeuvred below the acromion. The shaft of the plate was placed on the superior aspect of the clavicle and fixed with a k-wire, the reduction of fragments were confirmed by rotating image intensifier to get oblique views of fracture The plate since is well pre-contoured, hence aligns well with the clavicle, but was bent to suit if need be. The tendency of the plate is to slide anteriorly which can be negated by a pointed thin spike put in a screw hole and pulling it posteriorly to its optimum location. Our initial screws were normal screws, to get the plate in tight contact with clavicle, and then later fixed with locking screws. Adequate precaution was taken to avoid injury to the underlying neurovascular bundle. The wound closed without

tension, with subcutaneous sutures, to hold over the plate. Similarly surgical procedure was done with a precontoured locking compression plate (LCP, superior anterior clavicle plate with lateral extension) to fix the fracture, with the help of 3.5 mm locking and cortical screws on the medial side and 2.7 mm locking screws on the lateral side (Fig. 2(b)).
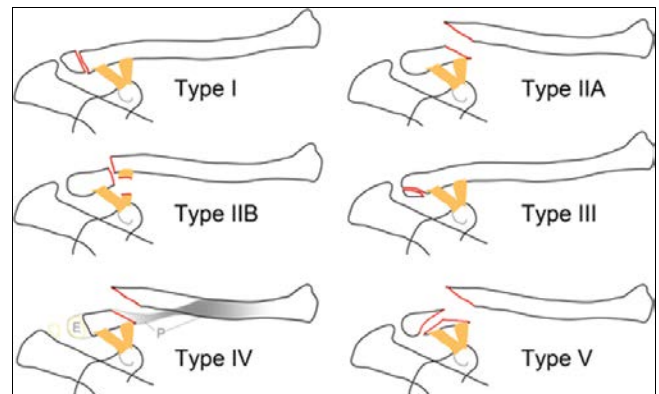
Fig 1: Neer's classification of distal clavicle fractures

a)   b)
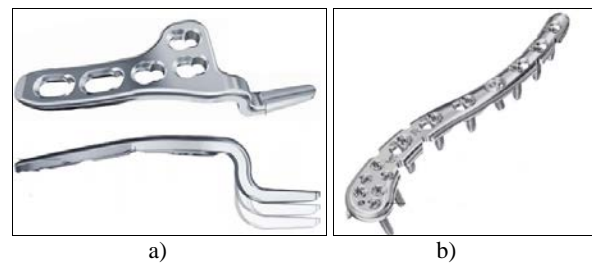
Fig 2: (a) Hook plate, (b) Locking plate

Postoperative care and follow up

Postoperative period was uneventful in all the cases. Arm pouch was given to all the patients for about two weeks and advised mobilization of the shoulder. Patients were discharged after 3-5 days and suture removal was done after 10 days. X-ray assessment of the clavicle was done on the 1st postoperative day and after every 6 weeks, until radiological union was achieved. The patients were followed up with the Constant–Murley scoring at the third and sixth month postoperatively.

Results

All the 39 patients with Neer's type II lateral clavicle fracture were operated with the clavicle hook plate (20 cases) and distal clavicle locking plates (19 cases) as retrospective and prospective ways. Out of 39 fractures, 28 (71.7%) were left sided and the average age was 33 years (range 21-60yrs) with male to female ratio was 9:4. The average age of the patients was 33 years with range 21- 60yrs. The common mode of injury was RTA (30 cases 77%) followed by fall at home (9 cases 33%).

The mean duration of surgical fixation since the time of injury was 3.3 days (range 1 day-6 days) and the average operating time was 60 minutes with range of 55 to 70 minutes from incision to closure. The average post-op stay was 5 days with range of 3-7 days. All the patients were followed up for average 1.5 years with range 6 months to 2 years and evaluated Constant Murley score at 3 and 6 months follow-up. The average duration of bony union was 16 weeks with range 8 – 20 weeks. Early Implant removal was advised after bony union with symptomatic patients, otherwise not advised routinely (Fig 3 & 4).

The average score at 3 months was 89.87(range 84.2-93.3) and at 6 months was 94.6 (range 88.4-96.1) for the distal clavicle locking plates, and for the clavicle Hook plates 86.3 (range 80.8-93.5) at 3months and 92.5 (range 86.7-94.3) at 6 months follow-up. The *P*-value is less than 0.05 in both groups at the end of 3 months and 6 months follow-up. Compared with the clavicle hook plate, the distal clavicle locking plate was associated with higher Constant-Murley scores at 3 months as well as at 6 months.

In our study, we had complications in 11 patients (28%) out of total 39 cases. During follow up, 4 patients were diagnosed with impingement syndrome and these patients had symptoms of discomfort and pain between 70 and 130 degree of shoulder abduction. Impingement was confirmed by impingement test i.e., local injection of 2ml of 2% lidocaine under the acromion in sub-acromial space, bringing relief to the pain instantly. These symptoms were resolved shortly with plate removal after bony union. There was no statistically significant difference between the clavicle hook plate and distal clavicle locking plate groups in terms of the occurrence of acromion impingement syndrome (*P*>0.05).

Three patients had the occurrence of shoulder pain. Compared with the clavicle hook plate, the distal clavicle locking plate was associated with a decrease in the occurrence of shoulder pain.

Three patients had the occurrence of delayed union. There was no statistically significant difference between the clavicle hook plate and distal clavicle locking plate groups in terms of the occurrence of delayed union.

Two patients had restricted shoulder abduction range of motion. Compared with the clavicle hook plate, the distal clavicle locking plate was associated with a decrease in the number of restricted shoulder abduction range of motion cases.

One patient who got infected required implant (locking plate) removal despite suitable intravenous antibiotics being injected after pus culture and sensitivity.

In one case of clavicle locking plate, plate pulled out from the lateral fragment due to failure to negate the displacing forces at the fracture site and went into non-union (Fig 5). Non-union was treated with exchange plating using clavicle hook plate with bone grafting.

In both prospective and retrospective study, a total of 39 patients were finally included and results showed that the better Constant-Murley shoulder joint function score in the distal locking plate group was better than that in the clavicle hook plate group at 3 and 6 months after the operation (*P*< 0.001). There were fewer cases of shoulder joint pain and restricted shoulder abduction range of motion in the distal locking plate group, and the difference was statistically significant (*P*< 0.05). There were no statistically significant differences in fracture delay healing and sub-acromion impingement between the two groups (*P* >0.05).
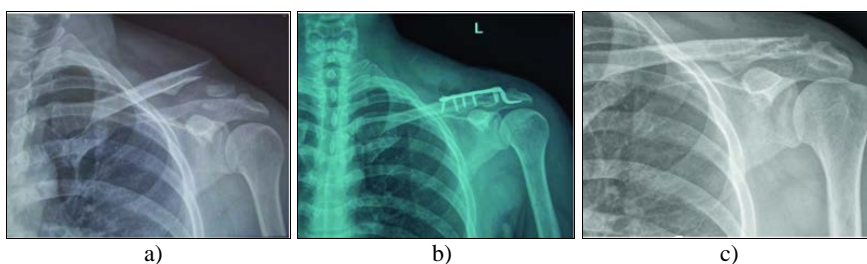
Fig 3: X-ray showing Hook Plate Fixation (a) pre post (b) post-op (c) after plate removal
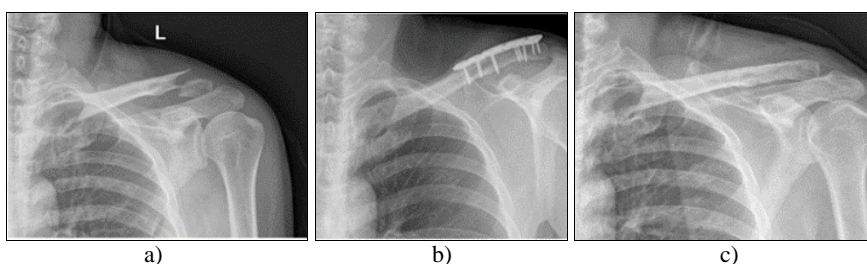
Fig 4: X-ray showing Locking Plate Fixation (a) pre post (b) post-op (c) after plate removal

Fig 5: (a) Showing non-union with locking plate back out

Discussion

Clavicle fractures are one of the most common injuries in an adult population and are being encountered increasingly due to increase in high-velocity trauma as seen in the young population. Due to more soft tissue injuries associated with these accidental injuries, the fracture fragments are displaced and require adequate reduction and fixation. We believe that the main indication for ORIF in clavicle fractures should be a displaced fracture of lateral end of the clavicle and not the mid-shaft fractures. The deforming forces are due to the powerful pull of the muscles pectoralis major, pectoralis minor and latissimus dorsi muscles, scapula rotation, and the pull of the sternocleidomastoid muscle) along with the presence of the coracoacromial ligament and the coracoclavicular ligament and the weight of the arm. They are responsible for the instability of the fracture along with malunion and nonunion, which leads to functional disabilities [15]. Improper surgical techniques and implant related complications are implant failure, infection, sub-acromion impingement syndrome, iatrogenic injury to

acromioclavicular joint leading to dislocation, restricted shoulder abduction (ROM) and shoulder pain (sub acromion bursitis, sub-acromion osteolysis). Hence, the need for surgical management using standard implant in the form of stable fixation is necessary. Neer type II fractures are usually comminuted, making the purchase of screws difficult, herein lays the advantages of the clavicle hook plates and lateral end clavicle locking plates.

Hook plate techniques have shown that the clavicle hook plate has fewer complications and allows earlier mobilization [16, 17]. Despite these advantages, complications can occur if the hook plate is retained. The first category is related to the freely movable hook of the plate that is placed posterior to the AC joint, below the acromion, and above the supraspinatus tendon. Even though the design of the hook plate promotes fracture healing by keeping the fracture fragments reduced without interfering with the rotational movement of the clavicle, this design also leads to complaints due to mismatch between the hook of the plate and the diverse anatomy of the acromion. El Maraghy et al. [18] demonstrated the mismatch between the plate and the subacromial space leading to several well described short term complications in an anatomic study. In 89% of the specimens the hook perforated the subacromial bursa, in 60% the tip had contact with the supraspinatus tendon and in 60% contact with the acromion was concentrated at the tip of the plate. These findings clarify the subacromial bursitis, the impingement complaints and the subacromial osteolysis respectively. They concluded that the anatomy of the acromion is too diverse to accommodate a single hook plate and when necessary the hook and the tip of the plate needs bending and smaller depths of the hook should be selected if necessary, especially for women [19]. Muramatsu et al. [20] found it necessary to bend the hook in 77% of their patients, and found in most of their patients migration of the hook after fixation. Their operative technique describes however, forcefully reducing the fracture using the plate as a lever. Impingement, subacromial bursitis and subacromial osteolysis on x-ray are signs of a mismatch between the plate and the anatomy of the patient. These complications can be minimized by performing an anatomic fit of the plate during the procedure.

Fixation of fractures of the lateral clavicle with locking plates is a relatively new technique [21, 22]. This mode of fixation is an extension of the fixed angle, locking screws principle, which has been used in other fractures, most notably fractures of the proximal humerus and distal radius. Although several implant manufacturers have recently introduced locking plates into the market for lateral clavicle fractures, we do not know of any rigorous evaluation of the technique reported in the English literature. A review appraising the different modalities of treatment had proportionally small number of studies which had assessed interfragmentary fixation [21]. This illustrates our point that more research into the use of this technique is required. We think that it is important to highlight the technical shortcomings of the locking plates for lateral clavicle fixation such as fundamental failure of the technique to negate the displacement forces at the fracture site and failure to secure rigid fixation of small and multifragmentary distal fragment and the plate placed superiorly over the lateral end of the clavicle does not adequately neutralize all the forces acting at the fracture site, which act predominantly to pull the lateral fragment inferiorly [23]. However, biomechanical studies have shown that the clavicle locking plate is superior to the clavicle hook plate in terms of flexion and abduction of the humerus, because locking plate fixation maintains the biomechanics of the acromioclavicular joint, it allows some degree of early mobilization and does not require reconstruction of the coracoclavicular ligaments [24].

Klein et al. [25] retrospectively studied 38 patients with Neer type II clavicular fractures (fresh and delayed), treated with a hook-plate (22 patients) or with superior locked plate with suture augmentation (16 patients) and found achievement of union in 36 of 38 patients (94.7%). Six complications occurred (15.8%) including 2 infections (5.3%), 1 hardware failure (2.6%), and 3 peri-implant fractures (7.9%). The complication rate was more (36.4%) in the delayed group than the acutely treated group (7.4%).

In a comparative study done by Chunlin Zhang et al. [26] the LCP plate was compared with the hook plate and in 66 patients (30 done by hook plate and 36 done by locking plate) and the clinical outcome was better in locking plate as compared to hook plate. The complication rates in this study were comparable to our study with a good surgical outcome.

Liang Li et al. [27] 2019, in their meta-analysis of comparative study (9 clinical trials involving 446 patients) of hook and lateral clavicle locking plates revealed that the improvement in the Constant-Murley shoulder joint function score in the distal locking plate group was better than that in the clavicle hook plate group at 3 and 6 months after the operation (P< 0.05). There were fewer cases of shoulder joint pain and restricted shoulder abduction range of motion in the distal locking plate group, and the difference was statistically significant (P< 0.05). There were no statistically significant differences in fracture delay healing and subacromial impingement between the two groups (P > 0.05).

Michael J Chen et al. [28] in their comparative study of locking versus hook plates in Neer type II & V clavicle fractures disclosed that all fractures healed without loss of reduction, regardless of implant selection. 83% of hook plate patients underwent planned implant removal, while 37% of locking plate patients requested implant removal secondary to irritation.

Erdle et al. [29] retrospectively studied 32 patients (19 Hook Plate Osteosynthesis, 13 Locking Plate Osteosynthesis) with a mean age of 44.1 ± 14.2 years at surgery. Both HPO and LPO were equally effective in relation to restoration of vertical stability, overall functional outcome and fracture consolidation in treatment of Neer IIB fractures. HPO was associated inferior ACJ-specific outcome (Taft-Score) and a higher overall complication rate.

We compared the occurrence of delayed union between the clavicle hook plate and distal clavicle locking plate groups. We found that there was no significant difference between the occurrence of delayed union between the clavicle hook plate and distal clavicle locking plate groups. We then compared the occurrence of shoulder pain and the restricted shoulder abduction range of motion cases between the clavicle hook plate and distal clavicle locking plate groups. Compared with the clavicle hook plate, the distal clavicle locking plate was associated with a decrease in the occurrence of shoulder pain and a restricted shoulder abduction range of motion cases.

Conclusion

In conclusion pre-contoured locking plates provide adequate stable fixation for the lateral end clavicle fractures in compare to clavicle hook plate and are not associated with any major complications. However clavicle hook plate may cause impingement and sub-acromial osteolysis, without leading to functional impairment, has produced good short term as well as mid-term results. These complications can be minimized

by meticulously adjusting the plate to the individual anatomy with verification under fluoroscopy and the short term follow up after plate removal, impingement complaints and the osteolysis disappear. Some limitations of this study should be noted as the small sample size might have affected the significant difference between the two surgical procedures.

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