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Research Article

Hook Plate Fixation of Lateral one Third Clavicle Fracture with Coracoclavicular Ligaments Repair

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Abstract

Background: There is no consensus regarding fixing displaced lateral one third clavicle fracture type 2 according to Neer classification, in this study Hook Plate (HP) fixation with Coracoclavicular (CC) ligaments repair was assessed to determine pros and cons.

Methods: In this prospective study, Twenty six patients of acute displaced lateral one third clavicle fracture type 2 according to Neer classification treated with Hook Plate (HP) fixation with Coracoclavicular (CC) ligaments repair were available for this study. Radiologic assessment points included quality of reduction, fixation and degree of union. Clinically, patients assessed using The University of California - Los Angeles (UCLA) Shoulder Scale for pain, shoulder function and range of motion.

Results: Results were evaluated after at least 12 months . all fractures united within 4 months period. The mean (UCLA) score range from 31-35, excellent in 8 patients (30.8%) and good in 18 patients (69.2%). 10 patients (38.4%) had subacromial impingement which improved after removal of implant, their functional scores were still less than non impinged patients.

Conclusion: HP with CC ligaments repair achieved excellent and good clinical scores and radiological outcomes in displaced lateral one third specially extreme distal and comminuted clavicle fracture with the disadvantages that include the necessity of removal and impingement in some cases.

Keywords: Coracoclavicular ligaments repair; Neer 2 lateral clavicle fractures; Clavicle Hook plate

Introduction

Displaced lateral one third clavicle fracture carries the risk of nonunion requiring fixation which is agreeable by many authors [1-3]. What is not agreeable is how we fix it. Variable tools and techniques were described in this regard, including: Kirshner wire, tension band, CC ligaments augmentation (tight rope, loop or screw) and clavicular Hook plate with or without CC ligaments repair [4-6]. HP rised as optimal fixation allowing screws in the main body of the clavicle, bypassing any comminusion and the inadequate remaining lateral clavicle and engaging the under surface of the acromion with its hook which prevents upward displacement of unstable medial clavicle [7-10].

K wire or tension band were shown in literature as easy and economic methods of fixation yet both carry risks of pin migration, loss of reduction and non union [11-15]. In this study, we adopted HP use to avoid the aforementioned potential risks of K wire or tension band use. Early removal of HP [16] plates means that we need biological method to ensure stability, so we assumed that the CC ligaments repair is mandatory so that when the HP removed bony healing of the fracture and ligamentous healing of CC ligaments will be solid enough against stresses.

Patients and Methods

This prospective study was conducted from march 2016 to November 2019. Initially, 32 patients with displaced lateral one third clavicle fracture were treated by HP and CC ligaments repair but 5 were lost in the follow up so 27 (20 males and 7 females) patients were available for the study. Age ranged from 23 to 55 years old (mean 39±16). Mechanism of injury was motorcycle accident in 16 patients (59.3%), fall from height in 8 patients (30.6%) and pedestrian accident in 3(11.1%).

Inclusion criteria were (1) displaced Neer type 2 fractures lateral clavicle including extreme patterns within 5 to 10 mm from Ac joint with or without comminution and (2) acute injuries. Exclusion criteria were (1) open injuries; (2) previous osteoarthritis shoulder and (3) associated shoulder injuries e.g. floating shoulder.

Lag time to surgery was 2 to 7 days (mean 4.5 ± 2.5). The average follow up was 13.5 months (range: 12-18 months). Average time of implant removal was 6.7±0.8 (range 5.5 -7.5 months).

Demographics and clinical criteria demonstrated in Table 1 and Figure 1.

Criteria	
Sex(males/females)	20 males and 7 females
Age	23 to 55 , mean 39±16 years old
Time to surgery	2 to 7 days (mean 4.5 ± 2.5)
Time to implant removal	5.5 -7.5 months(mean 6.7±0.8) .
The average Follow up	12 – 18 months (Mean 13.5 months).

Table 1: Demographics and clinical criteria.

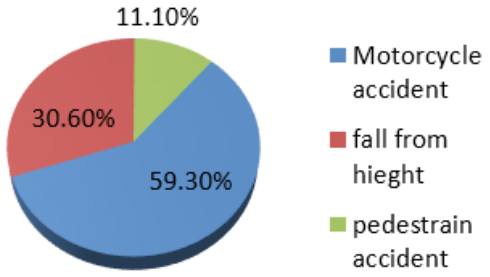

Figure 1: Mechanism of injury.

Surgical Technique

General anesthesia with head supported and tilted away in beach chair position was used with the advantage of easier image fluoroscopy use and free access to the shoulder all around, there were no medical contraindications regarding positioning in our cases. Vertical acromioclavicular incision allowed to operate on the fracture and the CC ligament repair comfortably with no undue retraction or risk to subcutaneus nerves which run vertically across clavicle. The skin incision followedby subcutaneous dissection starts at the tip of coracoids process running upward and laterally crossing over the acromioclavicular joint to the posterior border of the acromion. The clavipectoral fascia is opened in the transverse plane plane, periosteum is elevated exposing fracture site and partially the acromion, and the attachments of the conoid and trapezoid ligaments were identified. Wound irrigation and removal of clots from fracture site was performed. Using Ethibond number 5 sutures the CC ligaments were repaired or reattached (by drilling a hole in distal clavicle) to restore upward displacement of the medial clavicle. With the fracture held provisionally using reduction forceps with or without temporary wires. Small incision in the posterior part of the acromioclavicular (AC) joint for easier hook positioning. Hook depth (12mm-15mm-18mm) is chosen using trials of HP [17] in order to avoid over-reduction of the clavicle by smaller hook leading to acromial erosion and later fracture, while using larger hook depth can lead to loss of reduction.

Tips to avoid pitfalls with HP can be summariezed as follow: (1) if the tip of the hook meets resistance in the acromion, check the reduction and orientation of the plate in the transverse plane (anterior-posterior), (2) patients size varies so trial HP depth is necessary, (3) obliquity of the acromion shows anatomical variations so tip of the hook can be bent accordingly, (4) avoid repeated bending of the hook to avoid material failure, (5) fluoroscopic check is mandatory to avoid mal-reduction. After fluoroscopic confirmation of proper reduction, making sure that there is no impingement, non locked screw closest to the fracture is used to properly fix the HP to the clavicle followed by sequential application of locked screws from lateral to medial. Minimal 3 screws thith proper length (6 cortices) are needed medial to the fracture.

Wound irrigation with saline, followed by vancomycin 500mg application in powder state to minimize infection .Haemovac drain is applied to be opened 2 hours after the procedure to make use of vancomycin applied. Patient is put in pouch arm sling with immobilizer supplied with adequate sedation and pain control. neurovascular status was checked after recovery from anesthesia. Drains were removed 24 hours later, stitches were removed after 2 weeks, the sling used for 3 weeks with passive range of motion after 3 weeks, active range of motion started after 6 weeks with physiotherapy and resisted exercises done gradual as tolerated after 10 weeks. Follow-up visits were monthly in the first six months, then every 3 months. Follow-up was done radiologically (plain anteroposterior xray and axial view) to assess the reduction, union (callus in at least 3 cortices or disappearance of fracture line) and to detect complications (implant Failure, secondary displacement, acromial osteolysis or AC osteoarthritis). Clinical follow-up assesses the range of motion, the patient compliance, role out infection or loss of fixation. The average follow up was 13.5 months (range: 12-18 months). Average time of implant removal was 6.7±0.8 (range 5.5 -7.5 months).

At the final visit, patients were assessed using (UCLA) shoulder score [10] for pain , function ,active forward flexion (range and strength) and patient satisfaction. Maximum score is 35, Excellent: 34-35, Good: 28-33, Fair: 21-27 and poor 0-20. Subacromial impingement presence assessed using Neer test.

	Score
Pain	
Present always and unbearable; strong medication frequently	1
Present always but bearable; strong medication occasionally	2
None or little at rest, present during light activities; salicylates frequently	4
Present during heavy or particular activities only; salicylates frequently	6
Occasional and slight	8
None	10
Function	
Unable to use limb	1
Only light activities possible	2
Able to do housework or most activities of daily living	4
Most housework, shopping and driving possible; able to do hair and to dress and undress, including fastening brassiere	6
Slight restriction only; able to work above shoulder level	8
Normal activities	10
Active forward flexion	
> 150°	5
120°–150°	4
90°–120°	3
45°–90°	2
30°–45°	1
< 30°	0
Strength of forward flexion (manual muscle testing)	
Grade 5 (normal)	5
Grade 4 (good)	4
Grade 3 (fair)	3
Grade 2 (poor)	2
Grade 1 (poor muscle contraction)	1
Grade 0 (nothing)	0
Satisfaction of the patient	
Satisfied and better	5
Not satisfied	0

Maximum Score = 35 points; Excellent = 30-35 points; Good = 28-33 points; Fair = 21-27 points; Poor = 0-20 points

Table 2: The University of California - Los Angeles (UCLA) Shoulder Scale.

Statistical analysis

The collected data was documented as mean ± SD. We used SPSS 20.0 software. $P < 0.05$ was considered statistically significant.

Results

Radiologically, all fractures united within 4 months period (3 months ±0.9), we had no distal clavicle ostoelysis, coracoclavicular widening or loss of fixation. Five cases showed acromial osteolysis which improved after implant removal. Clinically, one case was complicated with superficial infection which resolved completely with antibiotics and dressing. We had no implant failure or revision but all cases showed symptoms related to the hardware with varying degrees. Subacromial impingement detected by Neer test was found in 10 patients (38.4%) which improved after implant removal. All HP were removed. Time to implant removal ranged between 5.5-7.5 months (mean 6.7±0.8). At the final follow-up the functional (UCLA) score was excellent in 8 patients (30.8%) and good in 18 patients (69.2%). The mean (UCLA) score range from 31-35 (mean 33.4). We had no fair or poor scores (Figures 2-4).

Figure 2: Anteroposterior x-ray of 40 years old patient with Neer type 2 lateral clavicle fracture.

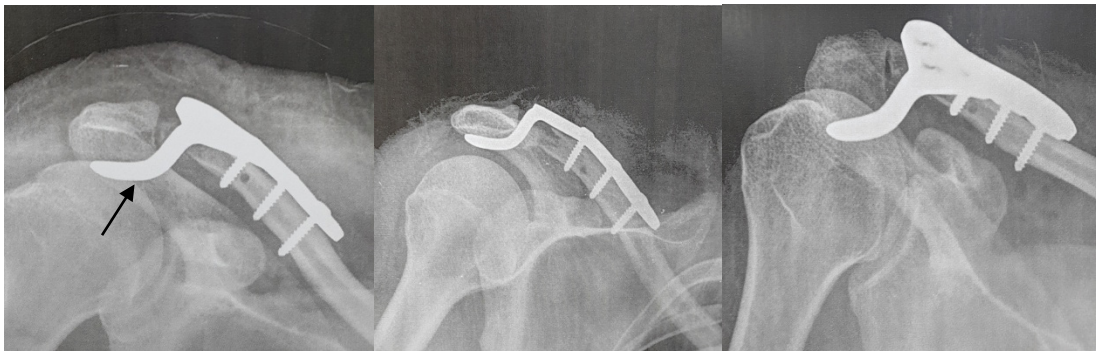

Figure 3: Follow-up different veiws x-rays of the same patient. The black arrow points to hole used to augment the CC repair.

Figure 4: Final x-ray of the same patient after removal of the implant.

Discussion

The lateral third clavicle fracture Neer type 2 has multiple pathomechanical aspects because it violates two stabilizing factors of the lateral end clavicle (1) the bony attachment of the lateral end of the clavicle (2) the ligamentous attachment of the coracoclavicular ligaments. So, it made sense that our goal is to reduce the displacement , mechanically fix it aiming to biologically restore those stabilizers. Conservative treatment was associated with unaccepted high incidences of malunion , nonunion, delayed union and functional deficits. Conservative treatment will neither reduce or fix the fracture or the CC ligaments [1,3,4].

Most authors advice surgical intervention with no consensus on the strategy or the method of that intervention. OH, et al. 2011 [3] did a systematic review of treatment options in lateral third clavicle fracture and found that surgical treatment had much lower rate of non union and concluded that intramedullary with or without interfragmentary screw fixation and CC stabilization had the least complication rate. We agree that CC stabilization is crucial [18] as it is part of the pathology but the fracture will dictate the method of fixation which makes the intramedullary fixation with or without interfragmentary screw not reproducible in every fracture specially in comminuted one. Regarding CC component of the pathology, Since our study was carried on acute fractures ,we used repair and even reattachment of the CC ligaments with no need of reconstruction using hamstring autograft, fiber tape or Ac tight rope. Regarding fracture fixation , literature is very controversial and contradicting (HP versus Kwires with or without tension band versus contoured locked plate).

Stegman et al 2013 [7], compared HP and other fixation methods and found no difference regarding union or functional results with higher complications in HP group compared to intramedullary fixation, Fleming, et al. 2014 [8] used precountered locked plate with union within 4 month with no need to remove the plate. Leu, et al. 2012 [9] compared HP versus tension band wiring and concluded that HP had better surgical and radiological outcome with no functional superiority due to impingement.

That contraversy can be explained by answering one fundamental question: how far distal is the lateral third clavicle fracture ? In our study we had 5-10 mm distal clavicle remained leaving almost no space to take screws lateral to the fracture without putting inadvertent screws in fracture site risking non union, the comminuted fractures in our study would not hold any screws at all risking unstable reconstruct. So contoured locked plate was not an option. In the literature [12-15], many authors showed the questionable stability of depending on kwire ,tension band or Knowels pin in addition to pin migration ,breakage , delayed rehabilitation and non union. We found that the only viable option in our study with all our cases either very distal or comminuted fractures is to bypass the fracture itself using the hook of HP to resist upward displacing forces. our rationale was aiming at biological fracture healing and CC ligamentous healing after reduction ,repairing CC ligaments and fixation by HP with fully understading of the limitations of the HP: (1) Different size pateints needed different hook depth (2) Anatomical acromion variations requires contouring of the hook. (3) To avoid complications, HP removal is essential after healing. (4) CC integrity is important to remove the HP safely with no risk of secondary displacement [19,20].

In our study, HP provide sound biomechanical stability with no sever restriction to shoulder motion or postoperative aftercare. But, subacromial impingement is major concern [21], found in 38.4% in our study lowering the functional score and the patient satisfaction which improved after plate removal yet lower than non impinged group. Meda et al 2006 [6] had 19% impingement (6 out of 31). Monsaert et al 2003[18] had 20% impingement (2 out of 10). El Maraghy et al 2010 [20] showed that the incongruency of hook of HP and acromion can cause subacromial impingement in cadaveric study. We found that the only solution is plate removal which we planned from the start. Acromial osteolysis is potential problem due to friction between the hook and the acromion risking later on fracture. We had 5 cases acromial osteolysis out of 26 may be due to late removal caused by their lack of compliance. After removal the osteolysis disappeared in all 5 patients with no fracture acromin occurred. Sukur, et al. 2016 [10] had acromial osteolysis in 10 out of 16 patients (62%). Lin et al 2016 [21] had 50% incidence of acromial osteolysis. Shih et al 2015 [22], in biomechanical study found that acromial osteolysis decrease with longer plates. These authers [10,21-24], all agreed that the only solution is timely removal after union and ligamentous healing.

Time of removal is another controversial issue [25,26], since there is no method to verify ligamentous healing but bony healing can be assessed by serial radiographs. Most authors [17-18,23-27] remove the implant 4-6 months. In this study delay in removal up to 7.5 months caused by patients lack of compliance. Limitations of this study can be concluded in: there was no comparison regarding various modalities of fixation or CC repair, our number of patients is not enough to propose a consensus. The strength of the study was the homogenicity of fracture selection and the number of patients for such a rare fracture.

Conclusion

Hook plate fixation of lateral one third clavicle fracture with coracoclavicular ligaments repair is reliable, reproducible and effective method specially in extreme lateral and comminuted patterns .But subacromial impingement and acromial erosion are potential complications which are avoidable by timely(4-6 months) removal of implant here come the importance of CC ligaments repair and healing . Excellent and good functional scores with favourable radiological outcome were achieved with minimizing complications.

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