Abstract:

Background: This study was conducted to evaluate the clinical outcomes of acromioclavicular joint (ACJ) fixation with hook plate (HP) and continuous loop double endobutton fixation (CLDE) in treatment of the acute acromioclavicular joint (ACJ) dislocation.

Methods: In this retrospective study, 8 patients with HP and 9 patients with CLDE fixations were compared for acute ACJ dislocations. The patients were evaluated by various criteria including disabilities of the arm, shoulder and hand (DASH), American shoulder and elbow surgeons standardized shoulder assessment (ASES), UCLA shoulder rating scale, shoulder constant score, simple shoulder test (SST) and CC distance.

Results: The differences between the mean VAS scores for pain, DASH, ASES, UCLA shoulder rating scale, shoulder constant and SST were statistically significant in favor of the CLDE group. The mean differences of CC distance was 8.6±0.9mm in HP while it was 11.6±1.2 mm for CLDE; the operation time was in favor of HP fixation (51±13.3 min versus 105±9.7 min) (p<0.001 and P=0.008). There were 6 concomitant subacromial erosions and osteoarthritis in the ACJ of the HP group.

Conclusion: CLDE fixation had better clinical outcomes than HP fixation; however, it was a technically demanding procedure. HP maintained the CC distance better and its application was technically easy. HP needs a second surgery for removal and development of
subacromial erosion and osteoarthritis of the ACJ which can be regarded as the major concerns.

Key words: Acromioclavicular dislocation; Double endobutton; Hook plate; Closed-loop

Level of evidence: Therapeutic III.

Introduction:
The acromioclavicular joint (ACJ) represents the link between the clavicle and the scapula, which is responsible for the synchronized dynamic of the shoulder girdle. (1) ACJ dislocation with a prevalence of 9-12 % is a common shoulder girdle injury in active young adults (1, 2). ACJ dislocation is associated with acromioclavicular (AC) and coracoclavicular (CC) ligaments injuries. Rockwood classified ACJ dislocations into types I to VI based on the amounts of horizontal and vertical displacement of the lateral clavicle and CC distance (3). Biomechanical studies have demonstrated the importance of anatomical reconstruction of the AC and CC ligaments in cases of unstable ACJ injuries. The change in anatomical orientation of the scapula in unstable ACJ dislocations may lead to scapular dyskinesis in 70% of the patients were treated with non-surgically methods and 45% of patients may present with SICK scapula syndrome including scapular malposition, inferior medial scapular winging, coracoid tenderness and scapular dyskinesis. Scapular dyskinesis changes the dynamics of the rotator cuff which can predispose to chronic shoulder pain (4-7). Non-operative treatments have been generally accepted as the gold standard of treatment in Rockwood I and II lesions, whereas the treatment of grade III is controversial and individualized. ACJ dislocations grades IV–VI generally require operative treatment. There is no gold standard treatment for ACJ dislocations type III and greater. The literature provides non-homogeneous comparative studies between the treatments of ACJ dislocations type III and greater (8-23). The aim of this study is to compare the clinical and radiographic results of acute Rockwood type III and greater ACJ dislocations treated with either rigid trans-articular hook plate (HP) or non-rigid extra-articular with continuous loop double endobutton (CLDE) fixations. The hypothesis of this study is that the clinical results of HP and CLDE CC fixations for acute ACJ dislocations had equal functional and radiographic outcomes.
Materials and Methods:

Through a retrospective study between March 2013 and March 2017, young athlete patients with ACJ dislocation who were candidate to surgery treatment were treated with CLDE or HP fixations. CLDE or HP fixations was offered and performed on 22 physically active high demand adult patients because of Rockwood type III and IV ACJ dislocations. We estimated 20 patients based on minitab13 statistical software according to previous study with power of 80%, sigma 0.7 (22). Patients with previous shoulder injury or surgery, congenital deformity in upper limb, neuromuscular disorder and Rockwood type I and II ACJ dislocations were excluded.

The lesions were the result of road traffic accident in 12 patients (54.5%) and falling on affected shoulder in 10 patients (45.5%). ACJ dislocations were evaluated by a standard anteroposterior radiograph of the shoulder and Zanca view. At the final follow-up the vertical distance between the inferior border of the clavicle and the superior border of the coracoid (CC distance) was measured in millimeter (mm) in both groups. Increase in CC distance by 50%–100% and more than 100% with respect to the contralateral side was considered as subluxation and redislocation, respectively. All the patients had a minimum of six months follow-up. This study was approved by the ethical committee of the university.

Twelve patients (11 males and one female) with the mean age of 37±12.2 underwent CLDE CC fixations. The mean follow up period was 19.8 ± 8.8 (range 6 – 36) months. We used open technique described by Struh (5). An auxiliary No. 5 Ethibond suture (Ethicon®) stitch replicating the course of the trapezoid ligament was tied. To augment the endobutton construct, the AC capsule and deltotrapezial fascia were imbricated. In one of the patients, reduction lost immediately after surgery because of fracture at the base of coracoid. He was treated with a HP and evaluated in the HP group. At the final follow-up ACJ was redislocated.
in two patients because of displacement of the clavicular and coracoid buttons (Figure 1).

They declined further surgery, therefore, these three patients were excluded and finally nine patients remained in this group.

Eleven patients (10 males and one female) with the mean age of 38.1±14.7 were treated with HP CC fixation. One patient had been transferred from the CLDE group to this group. The mean follow-up period was 23.8±12.9 (range 6 – 38) months. The fixation failed in one patient with morbid obesity and he declined a further surgery (Figure 2). One patient was lost in follow up and one patient declined to remove her HP. We offered to remove the HPs at three months post-surgery; however, because of patients’ preferences HPs were removed in 10.7± 4.8 months in 8 patients. The patients were evaluated at a mean of two months after HP removal. This group consisted of eight patients. In this group, presence of subacromial erosion, osteoarthritis and other probable adverse effects of HP were evaluated.

Table 1 demonstrates the characteristics of the two groups of patients. There was no significant difference between the age, gender, Rockwood type of ACJ dislocation, side and interval between the injury and surgery and follow-up. A significant difference was observed between the mean operation times of the two groups (P= 0.008: Man- Whitney test).

The patients were subjectively evaluated with the visual analogue scale (VAS) for pain (0; no pain; 10 worst possible pain), disabilities of the arm, shoulder and hand (DASH) score (0: no disability; 100: disabled) and American shoulder and elbow surgeons standardized shoulder assessment (ASES) (100: best score; 0: worst score). The patients were also evaluated subjectively and objectively with the UCLA shoulder rating scale (Range0-35: Good/Excellent > 27; Fair/Poor < 27), shoulder constant score (100: no pain; 0: maximum pain) and simple shoulder test (SST) (12: best score; 0: worst score). At the latest follow-up, the mean CC distances (mm) between the two groups were compared. This study was
conducted under the supervision of the ethics committee of Urmia University of Medical Sciences with code of 96-09-63-3041. All patients offered their written consent and they were free to participate.

To characterize the qualitative variables, frequency and percent were used; while the mean ± standard deviation and range of variations were employed for quantitative variables. To conduct inferential analysis, Fisher's exact test was used to compare the qualitative variables and the non-parametric Mann-Whitney test was applied for quantitative variables. P value less than 1% was considered statistically significant.

Results:

As earlier noted, three (27%) out of 11 patients in the CLDE group had failed surgery and hence they were excluded from the study. One (9%) out of 11 patients in the HP group had failed surgery that was also excluded from the study.

Table 2 shows the mean scores of the instruments in the both group. The differences between the mean VAS scores for pain, DASH, ASES, UCLA shoulder rating scale, shoulder constant and SST were statistically significant in favor of CLDE group.

The mean difference of CC distance was in favor of HP fixation. Six (75%) out of the eight patients had concomitant subacromial erosions and osteoarthritis of the ACJ in the HP group (Figure 3).

Discussion:

In acute ACJ dislocation, the AC and CC ligaments still have the potential to heal; so surgical techniques are aimed to align the ends of the torn ligaments to facilitate tissue healing. There are many different types of rigid trans-articular and non-rigid extra-articular fixations. In past,
wires and threaded pins were frequently used for temporary trans-articular fixation of the ACJ. However, pin migration or breakage, pin-site infection, fixation failure and recurrent instability after pin removal were major concerns with these conventional therapies. Bosworth screw was also used to stabilize ACJ extra-articularly; it however, may associate with coracoid fracture, erosion on the clavicle and loosening of screw. Extra-articular stabilization between coracoid and clavicle with cerclage using heavy sutures or high strength synthetic materials induced a sawing effect on clavicle due to the rotation of the clavicle. Meanwhile, sutures may fail because of knot slippage and suture breakage (1, 8, 12, 21).

In the recent years the two modern techniques that are commonly used for Rockwood type III and greater ACJ dislocations are rigid trans-articular CC fixation with HP and non-rigid extra-articular fixation using a suspensory loop with flip buttons. Each technique has its own advantages and disadvantages. The suspensory loop may be either a tightrope (single or double) (8-11), continuous loop with either a single (1) or double (4, 5) or triple endobuttons (17, 18, 20), synthetic ligament, multistrand titanium cable (16) and absorbable polydioxansulfate (PDS) sling (8).

In the current study, we used HP for rigid trans-articular CC fixation. HP fixation has a simple and easy technique; however, there are some concerns that HP may lead to shoulder pain and dysfunction. HP may crowd and violate the subacromial space and produce impingement syndrome with rotator cuff injury, produce subacromial osteolysis, osteoarthritis of the ACJ, implant failure and CC ossification (12-14). In this regard, a second operation is recommended to remove the adverse effects of HP upon ligamentous healing. Removal of the HP improves the shoulder functional scores (9, 12, 16). Chen et al. removed HPs in their study 8 to 12 months after the surgery. Among the patients in their study, 10 (30.3%) and 6 (18.1%) patients had subacromial osteolysis and osteoarthritis of ACJ,
respectively (12). In the current study, 6 (75%) out of the eight patients showed subacromial osteolysis and osteoarthritis of the ACJ which can be a major concern similar to other studies (15, 21).

In the current study, we used CLDE for non-rigid extra-articular CC fixation. The CLDE eliminates the problem of knot breakage and slippage that may occur in suture button techniques. The CLDE has a double strength of the native tendon. However, it is technically complex and a demanding task requiring longer operation time. It needs accurate drilling on the clavicle and at the base of coracoid. A large or misdirected drill holes can produce fracture through clavicle and coracoids (4, 5). In the current study, 3 (27%) out of the 11 patients had reduction loss and failed surgery.

The literature provides a plethora of heterogeneous comparative studies between non-rigid extra-articular and rigid trans-articular CC fixations for ACJ dislocations with contradictory outcomes. The majority of the studies are retrospective with a relatively low number of subjects and short term follow-up that can pool the acute and chronic ACJ dislocations as well as different types of Rockwood classification for ACJ dislocation together (4, 19). The authors have used minimally invasive, arthroscopic and open surgical techniques (7, 10, 19). In some studies, patients with radiographically displaced and redislocated ACJ were not excluded from the final evaluation and the inferential analysis (7, 11, 15). Cai et al. did not remove HPs at their final evaluation (11).

Metzlaff et al. found no significant clinical difference between the HP and minimally invasive reconstruction of suspensory loop with two flip buttons (19). Eschler et al. compared HP fixation with absorbable PDS sling in ACJ dislocations. They found no significant difference in functional outcomes of both groups; however, HP restored CC distance more accurately than PDS sling (15).
In a retrospective multicenter study, Natera-Cisneros et al. compared arthroscopy assisted tightrope fixation and HP fixation for acute high grade ACJ dislocations. Patients with non-rigid fixations had a better quality of life. However, 12 (60%) out of 20 tightrope patients achieved anatomic ACJ reduction. In their study, HPs were removed (on average) 3.98 months after surgery; but 7 (63.63%) out of 11 patients achieved anatomic ACJ reduction (7).

In a systematic review and meta-analysis, Arirachakaran et al. compared clinical outcomes and complications of the loop suspensory fixation devices including tightrope, synthetic ligament or absorbable PDS sling with hook plate fixation for the treatment of acute ACJ injury. They found that in short term, loop suspensory fixation had higher postoperative Constant–Murley score and lower post-operative pain; however, loop suspensory fixation showed higher complication rates (8).

In a prospective randomized study by Cai et al., HP was compared with tightrope fixation in Rockwood type III ACJ dislocations. For one year follow-up, there was no significant difference between Constant–Murley scores of the two groups. The difference of VAS scores was in favor of the tightrope group. Both groups achieved reasonable and satisfactory clinical and radiological outcomes. 3 (10%) out of 30 patients with tightrope fixations had complete ACJ redislocations. The authors did not remove HP during the study (11).

In the current study similar to other researches, the non-rigid extra-articular CLDE CC fixation exhibited better clinical outcomes compared to rigid fixation with HP (in short term). However, it was a technically demanding procedure with a longer operation time and higher rate of failure. HP maintained the CC distance better and its application was more feasible. HP needs a second surgery for removal and development of subacromial erosion and osteoarthritis of the ACJ which is one of its major concerns.
The limitations of study were low sample size due to low incidence of ACJ dislocation. The contaminant reconstruction of ligament with the CLDE or HP techniques was useful and need to more evaluate in the future studies. However in this study we appropriate follow-up of our patients after HP discharge and all complications were recorded honestly.

The current study was a short term, retrospective, single center study with a small number of patients. We suggest further multicenter studies with a larger number of patients, longer follow-ups, randomized and prospective design.

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Conflict of Interest

There is no conflict of interest for report.

Ethical Issues

This study was confirmed by ethics committee of …….University of Medical Sciences.

References:


**Figure captions:**

**Figure 1:** Re-dislocation of ACJ because of CLDE failure at the clavicular button

**Figure 2:** Re-dislocation of ACJ with HP.

**Figure 3:** Subacromial erosion and osteoarthritis of the ACJ. HP removed 13 months after fixation