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ORIGINAL ARTICLE

Reconstruction of Conoid, Trapezoid and Acromioclavicular Ligaments in Acute Traumatic Disruption of Acromioclavicular Joint Using Semitendinosus Graft

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Background A common injury among sports and physically active people is a disturbance of the acromioclavicular (AC) joint, which makes up nearly 9-12% of all shoulder impairments. This study aimed to evaluate coracoclavicular (CC) ligament reconstruction in acute AC dislocation with special emphasis on range of motion, postoperative pain, recovery time and return to full work, and intraoperative and postoperative complications.

Subjects and Methods This prospective case-control study performed on 20 adults male or female patients suffering from acute AC dislocation and indicated for operative treatment.

Results Postoperative constant score was 92.5±6.5. The mean 6 weeks American Shoulder and Elbow Surgeons (ASES) was 40.15±2.18, 12 weeks ASES was 59.5±4.05 and 24 weeks ASES was 88.2±7.19. There was highly substantial variance between 6, 12 and 24 weeks ASES. Postoperative Disabilities of the Arm, Shoulder and Hand score was 9.5±3.5. The mean preoperative CC distance (mm) was 20±1.45, 6 weeks was 10.05±0.69 and 24 weeks was 10.15±0.81. There were highly significant differences between preoperative, 6 weeks and 24 weeks of CC distance (mm).

Conclusion Techniques for treatment of acute AC dislocation are viable surgical including hook plates, end button, and other options.
Regarding reconstruction of CC and AC ligaments using semitendinosus, this technique provides good outcome without using hardware and by trying to restore normal anatomy and kinematics.

Keywords Acromioclavicular, Coracoclavicular, Semitendinosus.

INTRODUCTION

The acromioclavicular (AC) joint connects the axial skeleton to the upper extremities, working with the remaining parts of the shoulder girdle to allow for smooth arm movements. Despite its small size and restricted motion range, the AC joint is a typical source of shoulder symptoms that are missed or assigned to the rotator cuff and glenohumeral joints, which gain greater interest from radiologists and are more prominent in the imaging literature [1]. A common injury among sports and physically active people is a disturbance of the AC joint, which makes up nearly 9–12% of all injuries of the shoulder [2].

Most of these injuries are not severe enough to require surgery. In cases when the shoulder impairment is more serious, surgery can be required. However, there is no agreement on the best way of reconstruction, with over 150 distinct approaches for operational repair of the AC joint being described in the literature [3].

In the past, nonoperative treatment has exceeded open procedures in terms of clinical outcomes for Rockwood grades 1, 2 and certain grade 3 divisions [4].

Surgical fixation in this region entails a danger of possibly disastrous migration of hardware into adjacent crucial tissues, in addition to the significant rate of failure related to these treatments [5].

Traditional techniques include using a coracoclavicular (CC) screw or trans acromial pinning to secure the joint using a hook plate. These techniques were linked to morbidity, hardware migration fracture, and the need for additional surgery [6].

The Waver–Dunn surgery or the transfer of the CC ligament to replace the weak CC ligaments were two reconstructive therapy options for AC dislocation [7].

Mazzocca *et al*., [8] reported an anatomic reconstruction of the CC ligaments in acute AC dislocation, which improved clinical and biomechanical outcomes when compared with previous methods of management displayed better biomechanical and clinical outcomes when compared with previous therapeutic approaches.

In this study, we aimed to evaluate CC ligament reconstruction using semitendinosus graft in acute AC dislocation with special emphasis on a range of motion, postoperative pain, recovery time, and return to full work, intraoperative and postoperative complications, and comparing with other studies using the concept of reconstruction and other common methods.

SUBJECTS AND METHODS

Patients

This prospective case–control study was performed on 20 adults male or female patients suffering from acute AC dislocation and indicated for operative treatment. Verbal and written informed consent were obtained from all participants after an explanation of the procedure and medical research. The research was conducted under the World Medical Association's Code of Ethics (Helsinki Declaration) for human research. This study was carried out after the approval of the Institutional Review Board (IRB).

Cases with the following criteria were included; complete AC dislocation (starting from grade 3 according to Rockwood classification, acute AC dislocation, athletes, and nonathletes).

Cases with the following characteristics were excluded; patients with incomplete AC dislocation (grades 1 and 2), patients with fracture dislocation, patients with vascular injury, floating shoulder, immunocompromised patients, porotic patients, and chronic AC dislocation.

Methods

Full clinical assessment which includes complete history taking, clinical examination, and imaging (plain radiograph in the form of Zanca view and computed tomography if indicated) evaluation.

Operative technique

Under general anesthesia, the surgery was performed in the beach chair position. To inhibit protraction, a tiny towel pump was inserted along the medial side of the scapula. The case was put far lateral in the bed to allow for imaging (Zanca and anteroposterior view bilateral) and free extension of the arm. A tourniquet was put above the knee in ipsilateral sight. Draping and preparation of the shoulder till midline and the lower limb from below tourniquet till foot. Harvesting of semitendinosus, preparation of the graft by high strength nonabsorbable suture in both ends under tension to avoid creep (the minimum length is 110mm). A Bra incision was performed over the clavicle about 3.5cm medial to the AC joint, along Langer lines, beginning posterior to the clavicle and crossing just medial to the apex of the coracoid process. The incision was long enough to allow for visualization of the AC joint. As a full-thickness flap, the preparation of bone tunnels in the clavicle as follow: the tunnel for conoid ligament was put 45mm from distal end clavicle just posterior to midline of the clavicle. The tunnel for trapezoid ligament was put 20–25mm lateral to conoid tunnel and anterior to midline of the clavicle. We used 4-5mm reamer. There were minimum 4mm of bone remaining in the periphery of the clavicle. Passage of the graft as figure of eight under coracoid and securing by tying the limbs of the nonabsorbable suture. Excision of distal 5mm of the clavicle. Stitching both limbs of the graft to make it one limb and using it to reinforce the AC ligament to ensure anteroposterior stability. The deltotrapezial fascia was lifted away from the clavicle. Passage of the graft as figure eight under coracoid and securing by tying the limbs of the nonabsorbable suture. Stitching both limbs of the graft to make it one limb and using it to reinforce the AC ligament to ensure anteroposterior stability. Deltotrapezial fascia was tightly closed, then closed in layers (Figure 1).

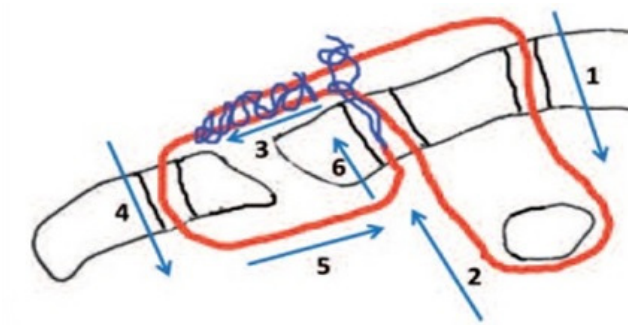

Figure 1: Graft passage and fixation, the line drawing shows the steps of graft passage and fixation.

Postoperative technique

Postoperative care

For 3 weeks, the arm was kept immobile in a shoulder immobilizer. For 3 days, 1 g of ceftriaxone was injected intravenously daily, with the first dose administered 30min before surgery. First postoperative radiograph as well as ones at 6 and 12 weeks.

Rehabilitation program

On the first postoperative day, gently aided passive motion range exercises for the shoulder were the focus of physical therapy. Beginning 1 week after surgery, assisted active activities were limited to 90 abductions until the fourth postoperative week. Following surgery, a full range of motion was allowed after the sixth or eighth week. Six weeks following surgery, shoulder muscle strengthening exercises were permitted. Sports competition and strenuous manual labor were postponed until the 12th postoperative week.

Follow-up examination

Cases were asked about their pain, capacity to work, ability to lift heavy weights, sports participation, and satisfaction with the surgical result during the follow-up assessment. The range of motion of the shoulder joint and any lingering deformity or tenderness over the AC joint were examined. The follow up extended 6 months after return to full activities.

Scoring

Constant, American Shoulder and Elbow Surgeons (ASES), and Disabilities of the Arm, Shoulder and Hand (DASH) scores were assessed at 6, 12 and 24 weeks postoperatively.

Statistical analysis

Data was analyzed statistically with SPSS, version 23.0. Quantitative data were described utilizing the mean, SD and range, while qualitative data were expressed using the number and percentage. To compare two groups of normally distributed variables, the *t* test was used. When applicable, the χ^2 test was employed to compare percentages of categorical variables. One-way analysis of variance was used to compare quantitative data between the two groups. A *p* value less than 0.05 is considered significant.

RESULTS

The mean age was 36.2±3.33, and 15 were male. The mean duration from the onset of trauma to surgery was 5.9±0.91, 12 had a right injury, 15 fell on an outstretched hand, three had road traffic, two with direct fall on the shoulder, 11 had associated injuries, 16 had associated abrasions, and eight had associated deformity. The mean hemoglobin was 10.98±0.65, platelet count was 188.2±14.59 and white blood cells count was 6.55±0.83 (Table 1).

Regarding the postoperative data, the mean time to return to work, was 4.2±0.77 months, resume full sports participation was 4.9±0.72 months, postoperative pain was 3.05±1.67, 11 cases reported excellent, seven cases reported good, two cases reported poor. Two cases had residual deformity. Concerning complications, two cases had wound infection, one had a frozen shoulder, and one had a fracture clavicle (Table 2).

Postoperative constant score was 92.5±6.5. The mean 6 weeks ASES was 40.15±2.18, 12 weeks ASES was 59.5±4.05 and 24 weeks ASES was 88.2±7.19. There were highly significant differences between 6, 12 and 24 weeks ASES. Postoperative DASH score was 9.5±3.5. The mean preoperative CC distance (mm) was 20±1.45, 6 weeks was 10.05±0.69 and 24 weeks was 10.15±0.81. There was a highly substantial variance between preoperative, 6 weeks, and 24 weeks of CC distance (mm) (Table 3).

The results remain the same after 6 months from return to full activities (Figure 2).

Table 1: Demographic, clinical, and laboratory data of studied cases

Age	**36.2±3.33**
Sex [*n* (%)]	
Male	15 (75)
Female	5 (25)
Site [*n* (%)]	
Right	12 (60)
Left	8 (40)
Mode of trauma [*n* (%)]	
Fall on outstretched hand	15 (75)
Road traffic	3 (15)
Direct fall on the shoulder	2 (10)
Duration from the onset of trauma to surgery	5.9±0.91
Associated injuries	11 (55)
Associated abrasions	16 (80)

Table 2: Postoperative evaluation of studied cases

Time to return to work (months)	**4.2±0.77**
Resume full sports participation (months)	4.9±0.72
Postoperative pain (as a part of Constant score)	3.05±1.67
Satisfaction [*n* (%)]	
Excellent	11 (55)
Good	7 (35)
Poor	2 (10)
Residual deformity [*n* (%)]	2 (10)
Complications [*n* (%)]	
Wound infection	2 (10)
Frozen shoulder	1 (5)
Fracture clavicle	1 (5)

Table 3: Constant, American Shoulder and Elbow Surgeons, Disabilities of the Arm, Shoulder and Hand score, and coracoclavicular distance evaluating among cases

	Mean (SD)	*p* value
Constant score		
Postoperative	92.5±6.5	
ASES		
6 weeks	40.15±2.18	<0.0001
12 weeks	59.5±4.05	
24 weeks	88.2±7.19	
DASH score		
Postoperative	9.5±3.5	
Coracoclavicular distance (mm)		
Preoperative	20±1.45	0.002
6 weeks	10.05±0.69	
24 weeks	10.15±0.81	

ASES, American Shoulder and Elbow Surgeons; DASH, Disabilities of the Arm, Shoulder and Hand.

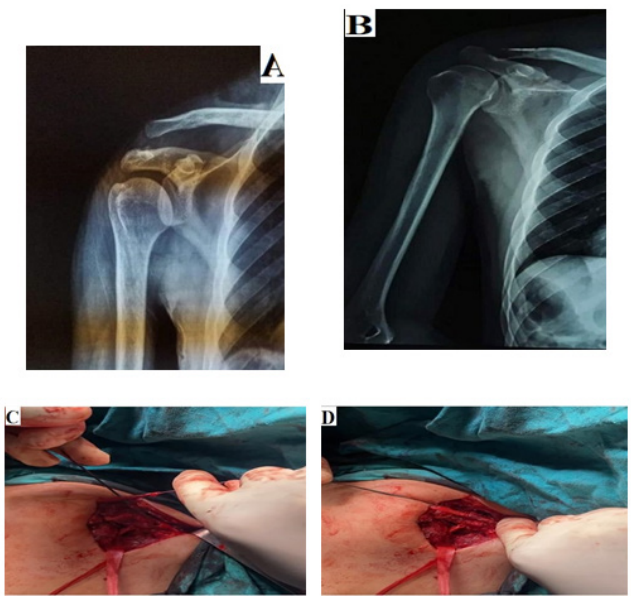

Figure 2: (a) Preoperative radiograph showing AC dislocation. (b) Postoperative radiograph. (c) Passing the graft to reconstruct conoid and trapezoid ligaments. (d) Reconstruction of superior acromioclavicular ligament. AC: acromioclavicular.

DISCUSSION

In his study, using semitendinosus graft to reconstruct AC and CC ligaments in AC dislocation, we found a good result comparing with other method in treating acute AC dislocation surgically, especially regarding this method contains no hardware, and trying to restore normal anatomy and kinematics.

AC joint injuries can occur due to various factors. The majority of injuries occur during extreme sporting events, with male players being at high risk. The CC and AC ligaments contribute to the stability of the AC joint. The selection of the necessary surgical approach for the therapy of AC disruption is a contentious subject due to the multitude of surgical choices for management. Moreover, the therapeutic efficacy of these operations is still debated, and several problems have been described. A dislocation may result from a direct or indirect mechanism of injury. A direct hit to the shoulder with the arm in an adduction position is the most frequent cause. Because the sternoclavicular joint is so strong, the clavicle and the AC joint are weak sites that are especially prone to damage [9].

AC injuries constitute a challenge to orthopedic surgeons in terms of evaluation and selecting the right surgical therapy. The ongoing dispute over the best successful surgical approach for treating high-grade AC injuries remains unresolved. Many surgical procedures have been defined, however, not all of them are without complications [10].

Bosworth [11] classically described his noncannulated CC lag-screw fixation technique to manage acute complete AC dislocations in 1941. Open reduction is performed on the AC joint dislocation followed by insertion of the screw between the distal clavicle and the coracoid process, lagging the clavicle inferiorly to an anatomical position.

In this study, we aimed to evaluate CC ligament reconstruction in acute AC dislocation with special emphasis on range of motion, postoperative pain, recovery time and return to full work, and intraoperative and postoperative complications.

This is a prospective case–control study; it will be performed on 20 adult male or female patients suffering from acute AC dislocation and indicated for operative treatment.

Venjakob *et al*., [12] revealed the findings of ~5 years of follow-ups in 23 cases who underwent two suture button fixations for acute AC joint dislocation. In comparison to baseline levels, cases showed substantial improvements in their visual analog scale (VAS) score (0.3±0.6) and Constant score (91.5±4.7), with 96% of cases reporting extremely satisfied or satisfied (p<0.05). In total, eight radiographic failures were recorded by this cohort, consisting of four extra CC distance overcorrections and undercorrection or posterior displacement.

Essawy [13] reported that the average operating time for treating acute AC dislocation with a hook plate was 66min (50–90min). The mean follow-up length was 20.3±7.8 months. After 3–6 months, the plates were taken off in all but one of the 22 cases. One patient (60-year-old active male) refused to remove the plate and missed follow-up after the third month and presented after 18 months with

full function and excellent range of motion, with only mild pain while working, and his plate was removed after 18 months from surgery. Regarding the range of motion at the end of follow-up, the mean forward flexion postoperatively was 160.4±15.8°, ranging from 120 to 180°; the extension was 51±8.6°, ranging from 35 to 75°; the internal rotation 58.1±11.7°, ranging from 35 to 85°; the external rotation was 68.1±12.7°, ranging from 45 to 85°; and the abduction was 160.4±18.3°, ranging from 120 to 180°. The mean postoperative constant score was 94±5.1. The mean DASH score was 8.7±4.8. The mean VAS score was 1.21. In this investigation, no complications were reported, nevertheless, one instance had a 1cm widening of the AC distance after 1 year that did not expand after that and the case was clinically free.

Concerning Hook plate technique, Essawy [13] reported that the mean DASH scores was 8.7, while the VAS score was 1.2. While Millett and Warth [14] reported that respecting ligament reconstruction, the mean DASH scores was 5.6 and ASES score was 93.8.

Essawy [13] reported that two cases developed radiologic arthritic changes in the distal clavicle but without clinical complaint. Even in the lone instance of a retained plate for 18 months, no cases experienced redislocation, wound infection, ossification of the AC ligament, or acromion osteolysis over the hook.

First published in 1972, the Weaver–Dunn approach uses the native coracoacromial (CA) ligament in AC joint repairs [6]. To reestablish AC stability, the distal clavicle is excised, and the CA ligament is transferred from the acromion to the distal clavicle remnant. Nevertheless, Weaver and Dunn [6] originally reported just a 75% good/excellent success with their original approach, therefore the clinical results for this operation have been insufficient.

Furthermore, previous research by Sood *et al*., [15] reported that there was little supportive data to recommend CA ligament transfers usage for dislocations of the AC joint. Because fixation-related problems are common, the researchers also observed that this fixation architecture is linked to a high probability of deformity relapse even when complement fixation is used.

In a previous investigation of 24 individuals with a mean follow-up of 37 months, Tauber *et al*., [16] demonstrated substantially improved clinical and radiographic results with anatomic semitendinosus CC ligament restoration than with a modified Weaver–Dunn surgery. Notably improved ASES scores (p<0.001), increased Constant scores (p<0.001), and reduced CC gap widening under stress (p=0.027) were seen in the semitendinosus CC ligament restoration group. Furthermore, as opposed to the Weaver–Dunn technique, horizontal instability might be treated with anatomic CC ligament repair.

Millett and Warth [14] observed substantial enhancements in mean postoperative SF-12 PCS scores (p=0.007) and ASES scores (p<0.001) compared to control. The QuickDASH score was 5.6, but the SANE score was 89.1. The researchers report a rate of complication of 22.6%, which included one adhesive capsulitis, two distal clavicle hypertrophy, two clavicle fractures, and two graft attenuation or ruptures.

Millett and Warth [14] reported an analysis of 12 papers that revealed difficulties after anatomic CC ligament restoration with biologic grafts, with a 39.8% rate of complication. Hardware difficulties, graft failure, and coracoid and/or distal clavicle fractures as a consequence of the bone tunnels are among the most prevalent complications.

In a group of 59 cases, Martetschläger *et al*., [17] estimated that the survivability of anatomic CC ligament restoration was 86.2% at 1 year and 83.2% at 2 years, with 27.1% as the rate of complication. Moreover, the investigators reported that 6-mm bone tunnels were connected to one coracoid and two clavicle fractures.

Milewski *et al*., [18] examined the side effects of 27 cases having AC joint reconstruction; 10 of these cases used a coracoid base loop, and 17 used a coracoid bone tunnel. The loop group had a complication rate of 35%, while the tunnel group showed an 80% rate of complication. Clavicle fractures were reported only in the loop group, whereas loss of reduction and coracoid fractures were observed in the tunnel group.

The concept that extensive bone tunnels substantially lower the stress required for the clavicle to fail is supported by recent biomechanical research [19].

To reduce clavicle or coracoid fractures, Millett and Warth [14] proposed an anatomic CC ligament restoration using an allograft loop around the distal clavicle and coracoid base using 3-mm bone tunnels rather than massive bone tunnels.

CONCLUSION

Techniques for treatment of acute AC dislocation are viable surgical including hook plates, end button, and other options.

Regarding reconstruction of CC and AC ligaments using semitendinosus, this technique provides good outcome without using hardware and by trying to restore normal anatomy and kinematics.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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