RESEARCH ARTICLE

Reconstruction of Acute Acromioclavicular (AC) Joint Dislocations with or without Tendon Graft: a Retrospective Comparative Study

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Abstract

Background: Reconstructions of acute acromioclavicular (AC) dislocations have been thought to result in superior outcomes than chronic dislocations. The use of tendon graft in reconstructions has demonstrated favorable biomechanical properties. To determine whether utilizing tendon graft during repair of acute AC dislocations results in superior outcomes and lower complication rate.

Methods: A retrospective review of AC reconstructions was conducted. Reconstructions performed within 3 weeks of injury were included. Inclusion criteria included age over 18, grade 3-5 AC joint separation, and no previous ipsilateral shoulder injury. Primary outcome measure was radiographic loss of reduction. Secondary outcomes included ASES and SANE scores.

Results: Of 47 reconstructions of acute AC joint separations, 35 utilized fixation without a tendon graft, while 12 underwent an anatomic reconstruction with tendon graft. Repairs without the use of graft resulted in 8 (23%) cases of loss of reduction, while tendon graft augmented repairs resulted in 5 (42%). This difference was not statistically significant ($P = 0.22$). No patients required reoperation. There was no statistical difference in the ASES and SANE scores between the two groups. Furthermore, we found no significant difference in ASES or SANE scores in patients who maintained reduction postoperatively versus those that lost reduction.

Conclusion: A greater but not statistically significant rate of loss of reduction was observed in the group reconstructed with the use of a tendon graft. Further research is needed to determine whether the use of tendon graft is beneficial in the treatment of acute AC joint separations.

Level of evidence: IV

Keywords: Acromioclavicular, AC reconstruction, CC reconstruction, Coracoclavicular

Introduction

The reconstruction of acromioclavicular (AC) joint dislocations remains a challenging problem despite a myriad of treatment options and techniques. Traditional treatment options included the Weaver-Dunn procedure, or transfer of the coracoacromial ligament to substitute for the deficient coracoclavicular (CC) ligaments in displaced AC joint dislocations (1). Other methods included transacromial pinning or hook

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plate fixation of the joint, and use of a coracoclavicular screw, which were associated with the morbidity of hardware breakage and migration and need for further surgery (2-6).

Bunnell and Lom described the use of autogenous fascia lata graft to augment the suture repair construct (7, 8). Subsequently, the use of autologous semitendinosus graft was reported in the reconstruction of a chronic AC joint dislocation (9). Costic et al. demonstrated biomechanically that an anatomic reconstruction of the CC ligaments using tendon graft augmentation can more closely approximate the stiffness of the native CC ligament complex than previous methods which did not use a free tendon graft (10, 11). A prospective comparative study was later conducted which showed that use of semitendinosus allograft resulted in superior clinical and radiographic outcomes when compared to modified Weaver-Dunn reconstructions.26

Mazzocca et al. described an anatomic reconstruction of the CC ligament complex, which demonstrated superior biomechanical and clinical results compared to earlier treatment options and without many of the aforementioned complications (12-14). Finally, the use of an endobutton and suture-only reconstruction techniques have recently been popularized, allowing for smaller incisions, and fixation without the use of a tendon graft (15). Despite the continued evolution from previous methods, complication rates have recently been reported as high as 50% (16).

Most surgeons believe that the acute dislocation represents a different problem when compared to chronic dislocations (17). Damaged structures theoretically retain the ability to heal in near anatomic positions, less scar tissue has developed, and reduction of the joint is more easily obtained than in chronic injuries. While the definition of acute versus chronic differs depending on the study, multiple recent studies have aimed to examine results following repair of acute AC dislocations (18-20).

We examined the structural and functional outcome and complication rates in the treatment of acute AC joint dislocations, defined as surgical repair within 3 weeks of injury, between patients treated without graft and those with an anatomic CC ligament reconstruction with use of a tendon graft (21).

Materials and Methods

A retrospective review of all acromioclavicular joint reconstructions over a 4 year period at a tertiary care center was conducted. Only reconstructions performed within 3 weeks of initial injury were included. Inclusion criteria included age over 18 years old (range 18-61), Rockwood type 3-5 AC joint separation, and no previous ipsilateral shoulder injury (22). Separations associated with fracture of the distal clavicle or scapula were excluded. Patients treated solely with suture fixation constructs were placed into Group A, while those that had a tendon allograft incorporated into the repair construct comprised Group B. Nine fellowship-trained surgeons performed the procedures at a tertiary care referral center.

Patients in Group A were treated with an open or arthroscopic assisted AC joint reconstruction utilizing heavy nonabsorbable suture endobutton constructs. Nine cases were performed with arthroscopic assistance, utilizing heavy nonabsorbable suture that required one drill hole in the clavicle and one hole through the coracoid (2.4 – 4.0 mm in diameter) [Figure 1]. Five of these cases used Arthrex Fibertape only (Arthrex, Naples, FL), three used #5 Arthrex Fiberwire the remaining case used one Fibertape and one #5 Fiberwire. These sutures were passed through an Arthrex Dog Bone in six cases and Arthrex Tightrope in three. The remaining 26 cases in Group A were reconstructed utilizing two drill holes (2.0 – 3.0 mm diameter) according to the conoid and trapezoid ligament insertions. Heavy nonabsorbable sutures (#5 fiberwires in 16 cases, Fibertape in 3 cases, fibertape and fiberwire in 4 cases, and Fibertape with 1mm Dacron tape in two cases) were passed subcoracoid and then through the clavicular tunnels and tied after reduction of the AC joint [Figures 2; 3]. The AC joint was then repaired with two Mitek QuickAnchor suture anchors (3mm) (Depuy/Synthes, Mitek Sports Medicine, Raynham, MA) in four cases, and with vicryl suture in nine. A distal clavicle excision was performed in one case.

Patients in Group B were treated with an anatomic reconstruction of the coracoclavicular ligaments following the technique as previously described by Carofino and Mazzocca (23). Two holes (5.0 – 6.0 mm diameter) were placed in the distal clavicle corresponding to conoid and trapezoidal ligament insertion (24). A semitendinosus allograft was then

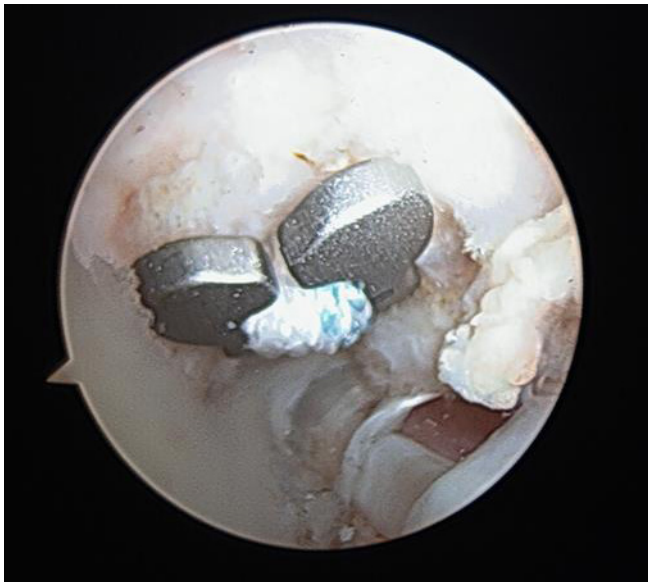

Figure 1. Utilizing heavy nonabsorbable suture that required one drill hole in the clavicle and one hole through the coracoid (2.4 – 4.0 mm in diameter).

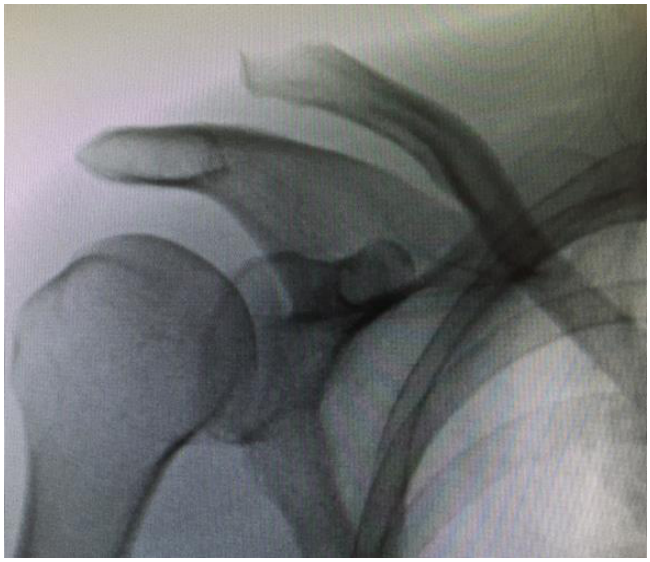

Figure 2. Before Fixation.

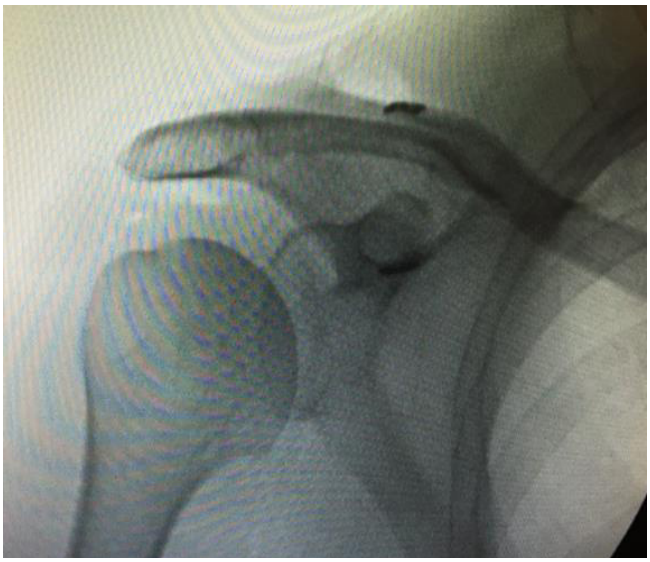

Figure 3. After fixation with tendon graft.

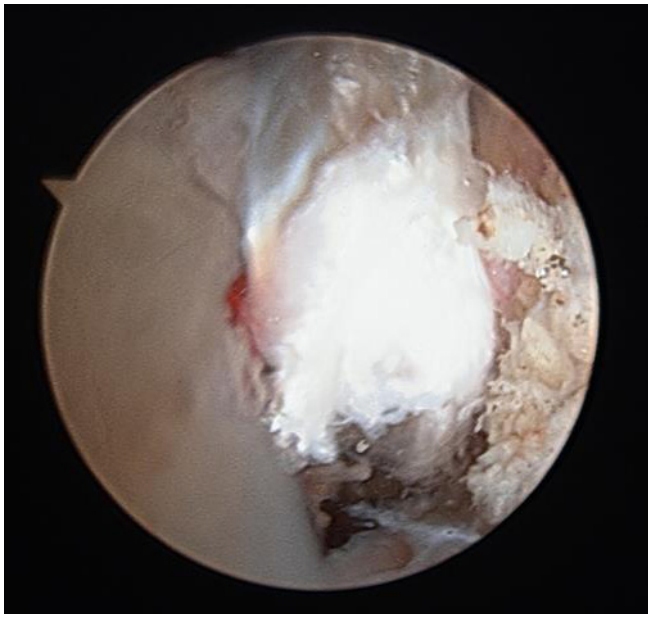

Figure 4. Semitendinosus allograft passed subcoracoid and secured into the clavicular tunnels using 2 Arthrex interference screws.

passed subcoracoid and secured into the clavicular tunnels using 2 interference screws [Figure 4]. Fibertape suture (8 cases), #2 Fiberwire (3 cases) or a 1mm Dacron Tape (1 case) was passed with the graft and tied to provide additional nonbiologic fixation. In 7 cases, the graft was passed over the top of the AC joint after passage through the clavicle to reconstruct the superior and anterior AC ligaments. In three cases, a 5 mm distal clavicle resection was performed.

Postoperatively, patients were seen according to the operating surgeon's discretion. A postoperative radiograph was completed intraoperatively or in the postoperative recovery unit. All patients were immobilized in a shoulder sling for a minimum of 4 weeks and had radiographs completed at regular intervals. Strengthening was not initiated until 3 months postoperatively. Patients were typically followed at 6 months and one year, and telephone interviews were conducted to obtain subjective scores.

Rockwood classification of the dislocations is displayed in Table 1. The primary outcome measure was radiographic loss of reduction. Preoperative, immediate postoperative and subsequent AP views of the operated shoulder were reviewed and CC interval distance was measured, using the superior point of the coracoid and nearest point of the distal clavicle. Loss of reduction was defined as change of more than 5 mm from the initial postoperative radiographs, as described previously (16). Films were reviewed by two separate reviewers and any discrepancy regarding a loss of reduction finding was brought to a third reviewer. Secondary outcomes included ASES and SANE scores. A student's t-test was used to compare complication rates and scores between the two groups, with $\alpha = 0.05$.

Table 1. Rockwood classification of the dislocations

AC Dislocation Type	Group A	Group B
Rockwood Type III	8	1
Rockwood Type IV	6	1
Rockwood Type V	21	10

Other complications including symptomatic loss of reduction, reoperation rates and pertinent sequelae of surgery were also recorded.

Results

A review of 47 AC reconstructions of acute dislocations was conducted, with 35 patients in Group A (fixation without tendon graft) and 12 patients in Group B (anatomic reconstruction with tendon graft). The average age of patients at time of surgery was 37 years (range, 18-61) in Group A and 36 years (range, 18-53) in Group B. Average follow-up duration for Group A was 2.7 years (range, 1-4.5 years), and 3.4 years for Group B (1-4.5 years).

Repairs without the use of graft resulted in 8 (23%) cases of loss of reduction (mean 9.3 mm, range 6.8-15.2 mm), while tendon graft augmented repairs resulted in 5 (42%), this difference was not statistically significant (*P=0.22*). Of the 5 cases in Group B that lost reduction, one resulted after the patient sustained a fall at home a year out from surgery. No fracture was seen on radiographs, and the patient was treated non-operatively. A second loss of reduction occurred when a patient from Group B had a physical altercation 6 months after surgery, which resulted in a clavicle fracture. She developed significant coracoclavicular displacement, but was satisfied with the overall outcome of subsequent nonoperative management. No patients required reoperation. Mean ASES score for group A was 96.2, and the mean SANE score was 97.6. For group B, the mean ASES score was 96.3, and the mean SANE score 96.7. There was no statistical difference in the ASES and SANE scores between the two groups. In the patients that maintained reduction at final follow up, mean ASES score was 96.8, and mean SANE score was 98.2 while patients that demonstrated loss of reduction had slight decreases in both scores, 94.6 and 95.4, respectively. This difference was not statistically significant (*P=0.08* and *P=0.06*, respectively).

Examining all patients with loss of reduction, no patient with a loss of reduction of at least 8 mm had an ASES score higher than 95, and the only patient with a score less than 90 in the group demonstrated more than 8 mm of loss of reduction [Figure 5]. There was no statistically significant difference in ASES scores when comparing patients with less than 8 mm loss of reduction to 8 mm or greater loss of reduction (*P=0.11*).

The two patients that sustained traumatic injuries 6 months and one year out from surgery demonstrated maintained reduction on radiographs postoperatively until their injuries. These may be deemed as re-injuries rather than a loss of reduction. We therefore also analyzed ASES and SANE scores with those patients removed, which increased mean ASES score of Group B to 97.5 and SANE score increasing to 98. These increases did not cause the difference between groups to demonstrate a statistical significance.

A multivariate analysis to determine the effect of AC ligament repair/reconstruction, distal clavicle excision and the number of tunnels used on outcome measures was also conducted. With the numbers available, none of these variables proved to have a statistical significance on ASES score (*P=0.12*, *P=0.21*, *P=0.52*, respectively), SANE score (*P=0.64*, *P=0.17*, *P=0.61*, respectively) or loss of reduction (*P=0.99*, *P=0.42*, *P=0.57*, respectively).

One patient in Group A developed heterotopic ossification and arthritis of the AC joint 2 years after surgery. One patient in Group B developed olecranon bursitis, which resolved without surgical intervention.

Discussion

Displaced AC joint dislocations continue to represent a complex problem. Despite a multitude of treatment options, there is no consensus regarding optimal management. While most surgeons believe that repair of acute separations should demonstrate decreased complications when compared to chronic separations, recent literature has demonstrated significant complication rates despite the use of modern techniques, including fracture of the clavicle/coracoid, bony erosion and loss of fixation. (25, 26)

Recent clinical studies have also examined the outcomes of suture only repair constructs in treating acute AC dislocations. Martetschlager et al. reported their results in utilizing #5 non-absorbable suture and cortical fixation buttons in patients treated within 2 weeks of injury (27). They reported a 23% complication rate in a cohort of 13 patients, including one coracoid fracture and 2 other cases of radiographic loss of reduction. Improved functional outcome were measured postoperatively, with no significant functional difference in patients who had a complication and those who did not, as also seen in our results. This may be the result of increased stability from the repair construct and subsequent healing, despite some loss of reduction.

Shin et al. reported their results performing an arthroscopically assisted CC reconstruction with use of the Arthrex Tightrope system in patients treated within 2 weeks of injury (18). In 18 patients, 6 (33%) patients had loss of reduction with 2 patients demonstrating more than 100% increase in CC distance compared with immediate postoperative imaging. They also reported 8 complications including 1 clavicle fracture, 3 cases of button failure and 3 cases of clavicular erosion. These studies demonstrate complication rates similar to that seen in our review (23%). This is not surprising, given the similar chronicity of injury at time of surgery, and methods of surgical fixation. Again, no significant functional difference was observed between patients that had a complication and those that did not.

While it has been shown that the use of a tendon graft to anatomically reconstruct the CC ligaments is biomechanically superior to a modified Weaver-Dunn repair, it is still not known whether a tendon graft is required in the treatment of an acute dislocation (12, 28, 29). Theoretically, the use of tendon graft has the advantage of providing biological fixation, and there is some evidence that the graft undergoes secondary vascularization, which should outlast an artificial suture repair construct (29). However, when taking into account the recent complication rates associated

with the larger clavicular tunnels required to pass a tendon graft, and subsequent risk of fracture and repair construct failure, the benefits of using a graft must be further investigated (16, 27).

In the setting of an acute injury, the ideal reconstruction method should provide enough strength to maintain the reduced AC joint and CC interval, allowing the soft tissues time to heal until the joint becomes stable (30). A biomechanical study investigating the properties of suture button systems utilizing 1 and 2 tunnels through the clavicle found that load to failure with regard to superior translation was equivalent to the native AC joint (28). Anterior and superior translation were also found to be less compared to the native joint for both single and double tunnel repairs, and double tunnel repairs also demonstrated less posterior translation. The suture button fixation system was superior to a modified Weaver-Dunn technique in all 3 directions, and there was no significant difference in those parameters between the single and double tunnel fixation techniques. These findings were similar to a previously completed study comparing a double tunnel technique to native joints (31). In our series, all patients treated with a tendon graft had two tunnels created in the clavicle. In the group treated by fixation without a tendon graft, 10 cases had one hole placed through the clavicle, while the remaining 25 had 2 tunnels placed. No significant difference was found in functional outcomes or radiographic loss of reduction between one or two tunnel repairs.

We found a non-statistically significant increased rate of radiographic loss of reduction in patients that had an anatomic reconstruction with tendon allograft. This may be due to tendon creep, failure of the graft/repair construct, fracture, and patient compliance. Two patients unfortunately reported significant traumatic episodes that resulted in loss of reduction, including one clavicle fracture. However, in all cases, patients were treated without repeat surgery and had overall good-excellent functional outcomes.

Other studies found in the literature include fixation methods using the flip button/polydioxanone (PDS) and a double button system to repair the AC joint. What is considered the best type of fixation is still controversial (32, 33).

A weakness of our study is a lack of uniformity in treatment. While semitendinosus allograft was used for all cases using tendon graft, there was variation in the sutures used and use of Arthrex Dog Bone or Tightrope devices in the non-graft reconstruction cohort. No standardization with regard to distal clavicle excision or number and location of clavicular tunnels was determined prior to treatment and the exact postoperative rehabilitation schedule was surgeon-dependent. Furthermore, some reconstructions included the repair or reconstruction of the AC capsule in addition to the CC ligaments, which may have a stabilizing effect on the AC joint as has been demonstrated biomechanically (34). Our results demonstrated no significant difference in ASES scores, SANE scores or radiographic loss of reduction between patients that had an AC reconstruction or repair, and those that did not.

We also lacked a large enough sample size to detect statistically significant differences in complication rates. A power analysis was performed utilizing a Fisher's exact test and assuming a 20% overall complication and $\alpha = 0.05$. With those parameters, a sample size of 260 patients would be required to determine a significant difference. We found that patients with a loss of reduction did not demonstrate a difference in ASES or SANE scores compared to those that maintained reduction, no patients with loss of reduction greater than 8 mm had ASES score better than 95. Although this difference is not considered clinically relevant, with a larger sample size a more clear difference in outcome compared to degree of loss of reduction may be demonstrated (35).

No patients required reoperation, which reflects the findings of other studies that despite elevated loss of reduction and complication rates, patients generally do well subjectively following reconstruction of the AC joint (19, 27). This may be due to some enhanced stability imparted on the AC joint by the reconstruction, despite evidence of radiographic loss of reduction.

We believe that this represents the first review of complication rates in the treatment of acute AC joint dislocations in patients treated with and without the use of tendon graft. We found a non-statistically significant increased rate of radiographic loss of reduction in patients who had an anatomic reconstruction with the use of tendon graft. While there remains a need for further research, this finding may be a reflection of the increased size of bony tunnels required to allow passage of the tendon graft, compared to modern suture-only constructs that allow for healing of the injured ligaments after reduction of the acute dislocation.

Patient Consent: Informed consent from study participants was not needed due to the nature of the study. All PHI was stripped from study data once the initial query was completed. Subsequently, patients were strictly referred to by an identification number.

Disclosure: The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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