Functional and Radiographic Outcomes After Anatomic Coracoclavicular Ligament Reconstruction for Type III/V Acromioclavicular Joint Injuries

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Background: Acromioclavicular (AC) joint separation is a common injury. The anatomic coracoclavicular ligament reconstruction (ACCR) technique is a viable treatment option, designed to restore the native joint anatomy.

Purpose: To evaluate the clinical and radiographic outcomes of patients undergoing ACCR for the treatment of type III and V AC joint injuries with a minimum 2-year follow-up.

Study Design: Case series; Level of evidence, 4.

Methods: A retrospective chart review was performed on prospectively collected data. Patients who underwent ACCR for type III or V AC joint injuries between January 2003 and December 2015 were analyzed. Clinical outcome measures included the American Shoulder and Elbow Surgeons (ASES) score, Rowe score, Simple Shoulder Test (SST), and Constant-Murley (CM) score. To determine the clinical relevance of the ASES score, the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptomatic state (PASS) were used. The pre- and postoperative coracoclavicular distance (CCD) and side-to-side difference in the CCD were measured for radiographic analysis.

Results: A total of 43 patients (22 acute, 21 chronic) were included in the study. The mean patient age was 43.4 ± 11.4 years, with a mean follow-up of 3.4 years (range, 2.0-7.5 years). With regard to the ASES score, 92% of patients achieved the MCID, 81% achieved the SCB, and 49% reached or exceeded the PASS. There was no significant difference when stratifying by type (III vs V) or chronicity (acute vs chronic) of injury (both $P > .05$). The Rowe score improved from 66.6 ± 15.9 preoperatively to 88.6 ± 12.3 postoperatively, the CM score from 61.6 ± 18.8 to 87.4 ± 15.1, and the SST score from 6.2 ± 3.6 to 9.4 ± 3.7 (all $P < .001$). The postoperative side-to-side difference in the CCD was 3.1 ± 2.7 mm, with type III injuries (2.4 ± 1.9 mm) showing significantly lower measurements compared with type V (4.2 ± 3.4 mm) ($P = .02$). No significant trend was found between joint reduction and the improvement in clinical outcomes ($P > .05$).

Conclusion: Patients undergoing ACCR for acute and chronic type III and V AC joint injuries maintained significant improvement in clinical and radiographic outcomes at a minimum 2-year follow-up. Additionally, 81% of patients reached the SCB after surgical reconstruction.

Keywords: anatomic coracoclavicular ligament reconstruction; ACCR; AC joint; acromioclavicular joint injury; shoulder surgery; clinical outcomes

Acromioclavicular (AC) joint injuries account for the vast majority of shoulder injuries, especially in athletes who engage in contact sports.[3,5,13,22,28,29] Although the incidence of high-grade AC joint injuries requiring surgery is low, indications for the nonsurgical versus surgical treatment of type III and V injuries produce controversy.[3,13,22,26] This disagreement has encouraged the development of multiple surgical techniques being proposed in the literature and may reflect a general dissatisfaction with treatment options and outcomes.[3,5,6,13,26]

Mazzocca et al[23] described an anatomic coracoclavicular ligament reconstruction (ACCR) technique, utilizing a semitendinosus allograft to replicate the coracoclavicular ligament in its anatomic location. Biomechanically, along

with other anatomic reconstruction techniques, this has been shown to be more effective in restoring native AC joint properties when compared with coracoacromial ligament transfer.[8,15,20,24] More importantly, using these anatomic techniques may lead to more favorable clinical and radiographic outcomes.[15,17,24,31,38] This technique has shown high subjective satisfaction rates among patients with a significant reduction in pain levels and improvement in shoulder function in the short term.[6] These findings are consistent with other studies reporting on the short-term to midterm clinical and radiographic outcomes of ACCR using free tendon grafts.[17,25,29,31,32,38] However, these studies were limited to a small patient population and short duration of follow-up.

Although this preliminary work is promising, longer term clinical and radiographic outcomes of patients undergoing ACCR have not yet been investigated. In addition, correlation between the maintenance of reduction and clinical outcomes is still poorly understood. The purpose of this study was to evaluate the clinical and radiographic outcomes of patients undergoing ACCR for the treatment of acute and chronic type III or V AC joint injuries with a minimum of 2-year follow-up. We hypothesized that patients undergoing ACCR would have significant clinical improvement with maintenance of radiographic reduction at final follow-up.

METHODS

Patient Selection

A retrospective chart review was performed on patient data collected prospectively from an institutional shoulder registry. All patients were recruited from a single shoulder fellowship–trained surgeon's practice (A.D.M.) between January 2003 and December 2015. Institutional review board approval was obtained before the initiation of the study. Patients eligible for study inclusion were those aged ≥18 years with an acute (defined as <6 months of nonoperative treatment) or chronic type III or V AC joint injury (defined by the Rockwood classification[3]) who underwent an ACCR procedure using a tendon allograft. All patients underwent a minimum of 1 month of nonoperative management, which included physical therapy. Those who were treated acutely included patients who failed to improve after a trial of nonoperative management or requested fixation based on a complete discussion of the risks and benefits of delayed treatment. A time of 6 months was chosen as chronic due to the 1-month

nonoperative management period, which all patients received as the standard of care. Although there is some debate in the literature regarding the exact definition of chronicity in AC joint injuries,[12] the trial of nonoperative management makes defining acute as 3 weeks unrealistic in this population. Exclusion criteria included patients with revision surgery; type I, II, IV, and VI injuries; and vulnerable populations (eg, prisoners, pregnant women, hospital employees).

Surgical Technique

Each patient underwent ACCR using a tendon allograft with interference screw fixation in the clavicle as previously described.[6,23] With the patient in the beach-chair position, an incision was made starting at the posterior edge of the clavicle 3.5 cm medial to the AC joint and extending inferiorly toward the coracoid process. Dissection was performed to the deltotrapezial fascia with electrocautery. The fascia was elevated off the clavicle by creating full-thickness flaps. All soft tissues preventing proper joint reduction were resected, and a trial reduction was performed.[6,23] Effort was made not to excise or damage the distal clavicle.

Once the clavicle was visualized, 2 bone tunnels were drilled into the clavicle according to the anatomic locations of the coracoclavicular ligaments. First, a 5-mm posteromedial tunnel was made, positioned 4.5 cm medial to the AC joint according to the anatomic insertion of the conoid ligament. Subsequently, a second anterolateral 5-mm tunnel was made, positioned 20 to 25 mm lateral to the center of the conoid tunnel, mimicking the trapezoid ligament. A minimum distance of 20 to 25 mm was maintained between tunnels, and the trapezoid tunnel was distanced at least 15 mm medially from the end of the clavicle to minimize susceptibility to clavicle fractures.[6,23]

Grafts were prepared from either semitendinosus or peroneus longus tendons. Under direct visualization, the graft was passed beneath the coracoid process from medial to lateral using a curved suture-passing device. Subsequently, the 2 limbs of the graft were crossed before being shuttled through the bone tunnels on the inferior aspect of the clavicle. Using the Hewson suture passer, the graft was first shuttled through the posteromedial tunnel. To remove any remaining slack, the graft was cyclically loaded by pulling it up on both ends. The lateral limb (trapezoid) graft was made 2 cm longer than the medial limb to re-create the AC joint capsule ligament.[6,23] High-strength nonabsorbable suture was used to take the excess lateral limb and suture

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it to the posterior tissue on the acromial side, using a horizontal mattress technique.[23] Any excess graft of the lateral limb was sutured to the trapezial fascia to re-create the posterior AC ligament.[23]

After visual and radiographic confirmation of AC joint reduction, graft limbs were secured sequentially (medial limb, then lateral limb) with interference screws while maintaining accurate reduction. Fixation was performed using interference screws (5.5×8–mm PEEK screw; Arthrex) placed along the anterior aspect of each tunnel, while tension on the graft limb was applied. Finally, graft limbs were secured onto the superior aspect of the clavicle, and the longer limb was used to reinforce the superior and posterior parts of the repaired AC capsule. Closure of the deltotrapezial fascia was performed with interrupted nonabsorbable sutures, with a running subcuticular closure performed on the epidermal layer.[6,23]

Postoperative Rehabilitation

Postoperative rehabilitation consisted of wearing a shoulder unloader brace (Lerman Shoulder Orthosis; DonJoy) for 6 weeks. This allowed for unloading of the shoulder to not apply stress to the AC joint reconstruction site. After 2 months postoperatively, patients were allowed to initiate upright range of motion exercises. If the patient was pain-free, strengthening exercises were implemented after 12 weeks, focusing on scapular stabilizers to decrease AC joint loads. Weight training was incorporated within 3 to 5 months, and contact athletic activity began as early as 6 months after surgery.[6]

Clinical Analysis

The primary outcome measure was the American Shoulder and Elbow Surgeons (ASES) score. Secondary clinical outcome measures included the Rowe score, the Simple Shoulder Test (SST), and the Constant-Murley (CM) score.[7,21,30] These scores were collected preoperatively and at a minimum of 2 years postoperatively. The Single Assessment Numeric Evaluation (SANE) score was obtained at only the final postoperative visit.[37] Previous studies have confirmed these scores in terms of reliability, validity, and responsiveness.[2,14,33,37] To determine the clinical relevance of the ASES score, the minimal clinically important difference (MCID), the substantial clinical benefit (SCB), and the patient acceptable symptomatic state (PASS) were used.[16] The MCID and SCB are used to quantify the clinical significance of a change in scores on an outcome measure.[16] The PASS is used as a threshold score associated with patient satisfaction.[16] While these metrics have not been examined in patients with AC joint injuries, they have been developed in shoulder arthroplasty[36] and rotator cuff tear[9] populations. Because current metrics are not available for patients with AC joint injuries, we utilized minimum changes from rotator cuff tears.[9] These included an 11-point change for the MCID, a 17.5-point change for the SCB, and a final ASES score of 86.7 for the PASS.

Radiographic Analysis

For radiographic analysis of vertical displacement, the pre- and postoperative coracoclavicular distances (CCD; in mm) were measured on unweighted anterior-posterior bilateral Zanca view radiography as the distance between the tip of the coracoid and the inferior cortex of the clavicle.[6,39,41] The side-to-side difference (in mm) in the CCD was obtained in relation to the noninjured contralateral side.

Statistical Analysis

Descriptive statistics including the mean and standard deviation for continuous variables, and the frequency and proportion for categorical variables were calculated to characterize the study groups. The change in the pre- to postoperative ASES score was used to determine which patients crossed the MCID and SCB thresholds. The final postoperative ASES score was used to determine whether patients met criteria for the PASS. Patients were then grouped according to injury severity (type III vs V) and chronicity (acute vs chronic). Differences in the proportion of patients meeting the MCID, SCB, and PASS thresholds between these groups were analyzed with the chi-square test or Fisher exact test when expected cell values were less than 5. Given the lack of adequate values for similar metrics, the mean values of the remaining outcome scores were compared. Differences in the magnitude of improvement (absolute difference between preoperatively and postoperatively) and final postoperative clinical scores and CCD were examined with an independent t test. Pearson correlation coefficients were generated to examine the relationship between postoperative clinical scores and the CCD. Results of inferential analysis are presented as 95% CIs.

Given that this was a retrospective analysis, the availability of data determined the sample size. A power analysis was performed to determine the capability of the sample size to detect a clinically meaningful difference for all patients from preoperative to postoperative MCID, SCB, and PASS thresholds for the ASES score. A sample size of 29 patients would provide 80% power to detect a 25% difference in the proportions of patients who achieved the MCID, SCB, or PASS at an alpha level of 0.05. The ASES score was the only outcome measure used for these metrics, as the Rowe score and SST have not been established for these parameters in this cohort. In addition, preoperative SANE scores were not collected in this study, so change could not be compared. The ASES score was also felt to be a better metric to use compared with the CM score, as it requires only patient subjective scoring. All analyses were performed with Stata statistical software (StataCorp).

RESULTS

Participants

In a single surgeon's (A.D.M.) practice, 79 patients underwent ACCR using a tendon allograft between
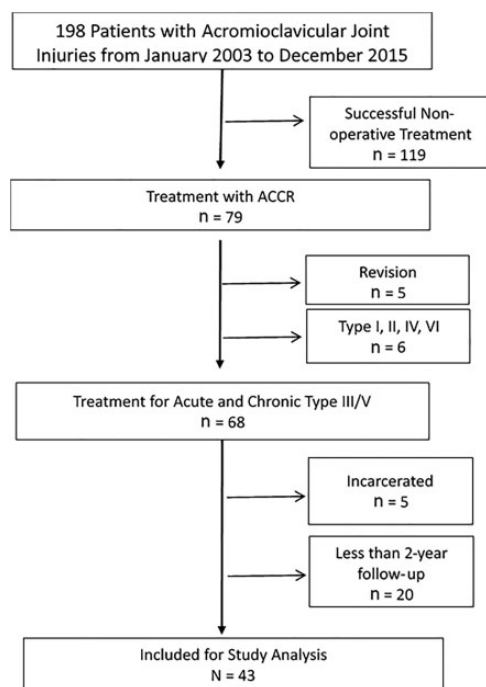
Figure 1. Flow diagram demonstrating patients included for study analysis.

January 2003 and December 2015. Of these patients, 43 patients (22 acute, 21 chronic) were eligible for inclusion in the study (Figure 1). The mean age of patients was 43.4 ± 11.4 years, with a mean follow-up of 3.4 years (range, 2.0-7.5 years). The median time from injury to surgery for chronic injuries was 15 months (interquartile range [IQR], 7-48 months). The median time from injury to surgery for acute injuries was 3 months (IQR, 2-5 months). The majority of patients were male (76.7%). Patient demographics are demonstrated in Table 1.

Clinical Outcomes

For all patients, 92% achieved the MCID, 81% met the SCB, and 49% reached or exceeded the PASS for the ASES score. When stratifying by type of injury (type III vs V), there was no statistically significant difference in the percentage of patients meeting the MCID (94% vs 90%, respectively [95% CI, –13% to 21%]), SCB (88% vs 75%, respectively [95% CI, –11% to 38%]), or PASS (53% vs 45%, respectively [95% CI, –24% to 40%]) (Figure 2). Similarly, when comparing the chronicity of injury (as defined by the parameters of the current study), there was no significant difference found in the percentage of patients meeting the MCID (91% vs 93%, respectively [95% CI, –20% to 15%]), SCB (77% vs 87%, respectively [95% CI, –34% to 15%]), or PASS (50% vs 47%, respectively [95% CI, –29% to 36%]) (Figure 3). The ASES score increased from 52.1 ± 19.9 (95% CI, 45.2-59.1) preoperatively to 82.0 ± 21.8 (95% CI, 74.4-89.6) postoperatively ($P < .001$).

TABLE 1
Patient Demographics (N = 43)[a]

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Sex	
Male	33 (76.7)
Female	10 (23.3)
Age, mean ± SD, y	43.4 ± 11.4
Follow-up, mean ± SD, y	3.4 ± 1.2
Dominant arm involved	25 (58.1)
Injury pattern	
Acute	22 (51.2)
Chronic	21 (48.8)
Type III	20 (46.5)
Type V	23 (53.5)

[a]Data are shown as n (%) unless otherwise indicated.

Additionally, there was a significant improvement in all secondary outcome measures from preoperatively to postoperatively. The Rowe score improved from 66.6 ± 15.9 (95% CI, 60.6-72.7) preoperatively to 88.6 ± 12.3 (95% CI, 83.9-93.2) postoperatively, the CM score from 61.6 ± 18.8 (95% CI, 54.1-69.0) preoperatively to 87.4 ± 15.1 (95% CI, 81.5-93.4) postoperatively, and the SST from 6.2 ± 3.6 (95% CI, 4.9-7.4) preoperatively to 9.4 ± 3.7 (95% CI, 8.1-10.7) postoperatively at final follow-up (all $P < .001$) (Figure 4). The postoperative SANE score for all patients was 85.7 ± 17.6 (95% CI, 79.6-91.9). At final follow-up, there were no significant trends in Rowe, CM, SST, and SANE scores between acute and chronic injuries (Table 2) or when comparing type III and V injuries (Table 3).

Radiographic Outcomes

When looking at the ipsilateral shoulder, the preoperative CCD (19.9 ± 6.4 mm [95% CI, 18.2-21.5]) was significantly higher ($P < .001$) than the CCD at final follow-up (9.7 ± 4.0 mm [95% CI, 8.6-10.7]). There was no significant difference in the pre- to postoperative difference in the CCD between acute (10.9 ± 6.9 mm [95% CI, 8.3-13.5]) and chronic (8.6 ± 6.9 mm [95% CI, 5.9-11.4]) injuries ($P = .23$). As expected, when comparing type III (7.9 ± 5.7 mm [95% CI, 5.7-10.2]) and type V (12.0 ± 8.0 mm [95% CI, 9.1-14.9]) injuries, type V injuries showed a significantly higher pre- to postoperative difference in the CCD ($P = .03$).

When comparing the ipsilateral (injured) to the contralateral shoulder, the postoperative side-to-side difference in the CCD was 3.1 ± 2.7 mm (95% CI, 2.4-3.8) for all patients. There was no statistically significant difference in the postoperative side-to-side difference in the CCD when comparing acute (2.9 ± 2.3 mm [95% CI, 2.7-3.1]) and chronic (3.3 ± 3.1 mm [95% CI, 2.1-4.4]) injuries ($P = .67$). However, type III injuries (2.4 ± 1.9 mm [95% CI, 1.7-3.0]) had a statistically significantly smaller postoperative side-to-side difference in the CCD when compared with type V injuries (4.2 ± 3.4 mm [95% CI, 2.7-5.6]) ($P = .02$).
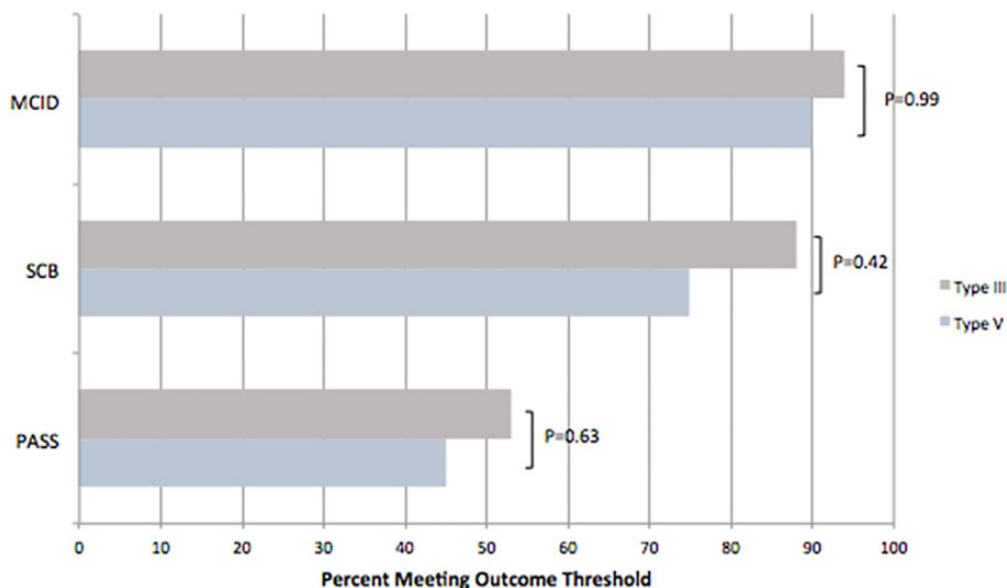
Figure 2. Percentage of patients with type III and V injuries who met the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptomatic state (PASS) for the American Shoulder and Elbow Surgeons (ASES) score.
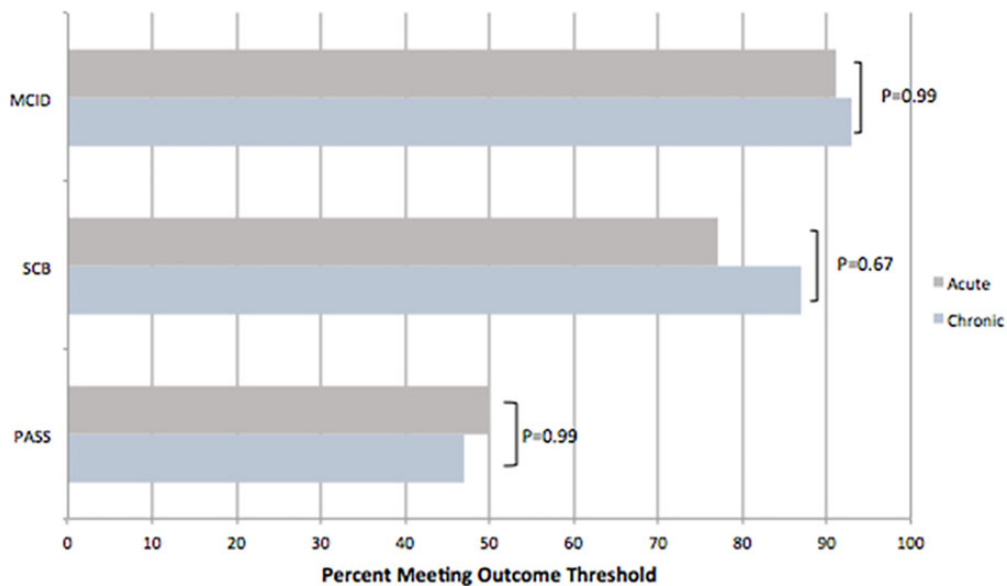

Figure 3. Percentage of patients with acute and chronic injuries who met the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptomatic state (PASS) for the American Shoulder and Elbow Surgeons (ASES) score.

We could not identify a significant trend between the postoperative side-to-side difference in the CCD and the improvement of pre- to postoperative values for the ASES, Rowe, SST, and CM scores ($P > .05$).

Complications

A total of 11 patients (25.6%) were found to have either clinical or radiographic complications after surgery.

Heterotopic ossification at or around the AC joint was the most common complication (n = 3; 7.0%); however, only 1 patient required debridement and distal clavicle excision for pain. Also, 2 of these patients had type V injuries, and all were chronic (>6 months from initial injury). Moreover, 2 other patients (4.7%) had deep infections requiring incision and drainage within the first postoperative month, while 1 patient had a superficial infection that resolved with antibiotics only. The 2 patients with infections
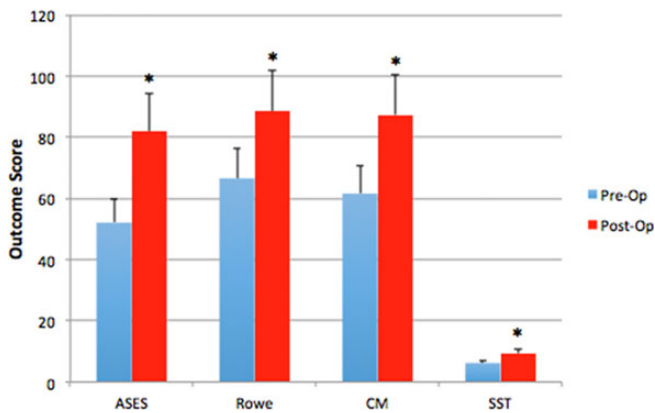
Figure 4. Preoperative and postoperative clinical outcomes at final follow-up for all patients undergoing anatomic coracoclavicular ligament reconstruction. *Significant improvement (*P* < .001) when compared with preoperatively. ASES, American Shoulder and Elbow Surgeons; CM, Constant-Murley; SST, Simple Shoulder Test.

requiring debridement had undergone previous shoulder surgery for either rotator cuff repair or debridement, one of which was an acute type III injury. The other infection requiring debridement was a chronic type V injury. AC joint osteoarthritis was observed in 3 patients, with only 1 requiring distal clavicle excision because of pain. All 3 had chronic injuries, with 2 of them being type III. An additional 2 patients had radiographic failure (recurrence of dislocation) within the first 8 weeks of surgery; however, both reported significant clinical improvement without requiring revision surgery. Both had type V injuries that were chronic. Overall, the complication rate was 26%; however, the reoperation rate was only 9%, with no patient requiring revision reconstruction.

DISCUSSION

The most important finding of this study was that patients undergoing ACCR for acute and chronic type III and V AC joint injuries maintained significant improvement in clinical and radiographic outcomes at a minimum 2-year follow-up. Additionally, this study found that 81% of patients reached the SCB threshold for the ASES score while only 49% of patients met the PASS criteria. Within the limitations of our study design, we did not observe a statistically significant relationship between the postoperative side-to-side difference in the CCD and the degree of improvement in clinical outcome scores. These findings are consistent with other studies reporting on clinical and radiographic outcomes after ACCR using free tendon grafts.[§]

A previously published case series of 16 patients who underwent the ACCR technique showed similar improvement in shoulder function and radiographic findings after a mean follow-up of 21 months (range, 6-68 months).[6] Compared with our longer term results, these results highlight

the ability of this technique to maintain reduction and shoulder function for patients with type III and V injuries.[6] Using a similar reconstruction technique, Millett et al[25] showed excellent clinical outcome scores and the maintenance of AC joint reduction with a mean side-to-side difference in the CCD of 2.3 mm in 24 patients who underwent treatment for type III and V injuries. Similar results were achieved by Parnes et al,[29] who reported on 12 patients treated with an arthroscopic ACCR technique using double-bundle coracoid cerclage for type V injuries. Although our findings mirror other studies on clinical and radiographic outcomes after ACCR, prior studies were limited to a smaller patient population and shorter duration of follow-up.[||] In addition, this is the first study that we are aware of that demonstrates the percentage of patients who reached the SCB and PASS for AC joint reconstruction. Nearly half of patients achieved the designated PASS threshold, which was similarly found for rotator cuff surgery.[9]

A biomechanical explanation for these favorable clinical and radiographic outcomes may be the ability of this technique to restore native AC joint properties more effectively when compared with coracoacromial ligament transfer techniques.[8,15,20,24] This biomechanical advantage has been supported by clinical studies comparing ACCR using free tendon grafts with a modified Weaver-Dunn procedure.[17,31] A prospective study by Tauber et al[31] demonstrated significantly superior functional and radiographic outcomes in patients who underwent ACCR using a semitendinosus graft at a mean follow-up of 3 years. These findings were confirmed by Hegazy et al[17] in a similar fashion.

As radiographic loss of reduction remains a major challenge in the treatment of high-grade AC joint injuries, surgical techniques addressing both the AC capsule and coracoclavicular ligament have garnered attention in the current literature, aiming to restore their synergistic effect and to create a repair site with maximum stability.[4,10,11,18,27] Thus, the ACCR technique reported on in this study utilized the longer limb of the free tendon allograft to reinforce the superior and posterior parts of the repaired AC capsule.[6] Ensuring the integrity of the AC capsule by additional augmentation leads to improved translational and rotational stability, as demonstrated in several biomechanical investigations.[11,27]

However, the correlation between the maintenance of reduction and clinical outcomes is still poorly understood. Loss of reduction in patients treated with coracoacromial ligament transfer techniques has been reported to occur in up to 24% of cases, being associated with inferior functional outcomes.[34,35] Even with additional augmentation, transfer of the coracoacromial ligament does not predictably maintain reduction of the reconstructed AC joint.[19] As the ACCR technique has been biomechanically proven to better restore native joint properties,[8,15,20,24] loss of reduction may be less likely to occur. Our study demonstrated that there was no correlation between functional outcomes and the maintenance of reduction, inferred from the

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§References 1, 6, 17, 29, 31, 32, 34, 38, 40.

||References 1, 6, 17, 25, 29, 31, 32, 38, 40.

TABLE 2
Postoperative and Change in Clinical Outcomes of Acute Versus Chronic Acromioclavicular Joint Injuries[a]

	Postoperative	P Value	Change From Pre- to Postoperative	P Value
Rowe		.32		.99
Acute	90.9 ± 11.6 (85.0-96.9)		21.9 ± 11.6 (16.0-27.9)	
Chronic	86.6 ± 12.6 (79.3-93.9)		21.9 ± 14.5 (12.7-31.1)	
CM		.49		.38
Acute	90.4 ± 11.2 (84.5-96.4)		28.7 ± 13.4 (21.6-35.8)	
Chronic	86.6 ± 18.1 (75.7-97.5)		23.0 ± 19.3 (9.2-36.8)	
SST		.27		.76
Acute	10.3 ± 3.0 (8.7-11.9)		3.6 ± 4.1 (1.4-5.8)	
Chronic	8.9 ± 4.0 (6.9-11.0)		3.2 ± 3.3 (1.5-4.9)	

[a]Data are shown as mean ± SD (95% CI). CM, Constant-Murley; SST, Simple Shoulder Test.

TABLE 3
Postoperative and Change in Clinical Outcomes of Type III Versus Type V Acromioclavicular Joint Injuries[a]

	Postoperative	P Value	Change From Pre- to Postoperative	P Value
Rowe		.40		.23
Type III	90.2 ± 11.5 (83.8-96.6)		25.1 ± 12.6 (17.5-32.7)	
Type V	86.4 ± 13.7 (79.4-93.4)		19.4 ± 12.5 (12.7-26.0)	
CM		.31		.91
Type III	90.8 ± 8.2 (86.4-95.1)		25.6 ± 13.9 (17.5-33.6)	
Type V	85.3 ± 19.5 (74.1-96.5)		26.2 ± 18.2 (15.2-37.2)	
SST		.62		.89
Type III	9.7 ± 3.9 (7.7-11.7)		3.3 ± 4.1 (1.2-5.4)	
Type V	9.1 ± 3.6 (7.2-10.9)		3.1 ± 3.7 (1.2-5.0)	

[a]Data are shown as mean ± SD (95% CI). CM, Constant-Murley; SST, Simple Shoulder Test.

postoperative side-to-side difference in the CCD. However, studies with larger patient populations, longer duration of follow-up, and more complete imaging (axillary and weighted views) are needed to determine to what extent loss of reduction may impair functional outcomes.

This study also found a complication rate of 26% at 2-year follow-up. This is similar to the findings of Millett et al,[25] who found a complication rate of 25.8%. However, unlike their study, clavicle fracture and graft failure were not the most common modes of revision in the current cohort. Our study found that heterotopic ossification and osteoarthritis of the AC joint were the most common complications after surgery, with all occurring in patients whose surgery was greater than 6 months from injury. This supports that fixation occurring before 6 months may play a role in delaying degeneration of the AC joint.

There are several limitations to this study. Although outcomes were collected prospectively, data were reviewed retrospectively, which could create selection bias. Moreover, a considerable number of patients either did not have 2-year follow-up or could not be reached, potentially leading to transfer bias. In addition, patients did not have standard weightbearing or axillary views of the shoulder at follow-up. This may have resulted in missed horizontal or dynamic instability, which has more recently been identified as a potential cause for persistent pain and revision. It also limits the current study's findings that maintained reduction did not correlate with

clinical outcomes. Another limitation was that the MCID, SCB, and PASS thresholds that were used may not be appropriate for patients with AC joint injuries.[9] As these metrics are derived from a rotator cuff tear population, it may not reflect those of patients with AC joint injuries.[9] This was felt to be the closest population available for utilization; however, further studies are required to identify the threshold for the current patient cohort.[25] Another limitation was the definition of acute and chronic injuries. Studies have varied in defining acute and chronic injures, with the lack of a true definition in the literature.[12,25] This is likely because of the variation in nonoperative management. Given that all patients in this population underwent a minimum of 1 month nonoperative management, 6 months was chosen to separate acute and chronic groups. While this may not reflect more common definitions in the literature, our findings of greater complications at 6 months may give insight into the risks of delayed treatment. This study also did not include a control group (eg, nonoperative treatment) to compare the increased benefit of ACCR. Although all patients underwent a trial of nonoperative treatment, further studies are needed to truly identify whether greater improvement is seen with operative management. This is especially true for type III injuries, which can often be treated nonoperatively.[3] Last, the patient population in the current study was older than the younger athletic population in whom these injuries

have been described,[3,13] making the results possibly less generalizable.

CONCLUSION

Patients undergoing ACCR using free tendon allografts for acute and chronic type III and V AC joint injuries maintained significant improvement in clinical and radiographic outcomes at a minimum 2-year follow-up. Additionally, 81% of patients reached the SCB after surgical reconstruction. Future studies comparing nonoperative treatment, as well as including weighted and axillary views, may give better insight into the added benefit of the ACCR technique.

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