

Functional Outcomes of Type V Acromioclavicular Injuries With Nonsurgical Treatment

Taylor R. Dunphy, MD
 Dhanur Damodar, MD
 Nathanael D. Heckmann, MD
 Lakshmanan Sivasundaram, MD
 Reza Omid, MD
 George F. Hatch III, MD

From the Department of Orthopaedic Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA.

Correspondence to Dr. Dunphy:
 taylor.dunphy@med.usc.edu

Dr. Omid or an immediate family member has received royalties from Integra LifeSciences and Medacta and serves as a paid consultant to Integra LifeSciences, Medacta, and Smith & Nephew. Dr. Hatch or an immediate family member is a member of a speakers' bureau or has made paid presentations on behalf of Arthrex. None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Dr. Dunphy, Dr. Damodar, Dr. Heckmann, and Dr. Sivasundaram.

J Am Acad Orthop Surg 2016;24:
 728-734

DOI: 10.5435/JAAOS-D-16-00176

Copyright 2016 by the American
 Academy of Orthopaedic Surgeons.

Abstract

Introduction: This study investigated nonsurgical management of type V acromioclavicular (AC) injuries to determine functional outcomes and to attempt to identify factors associated with positive results.

Methods: In a retrospective chart review, patients with radiographic and clinical evidence of type V AC injuries per the Rockwood classification were included in the study. Patients treated nonsurgically for ≥ 6 months were considered eligible for analysis. Functional outcomes were assessed using Disabilities of the Arm, Shoulder, and Hand (DASH) and American Shoulder and Elbow Surgeons (ASES) scores.

Results: Twenty-two patients with a mean age of 42.2 ± 12.8 years were included in the study. The average coracoclavicular distance at the time of presentation was 26.3 mm (+199%). Mean DASH and ASES scores were 27.8 ± 17.7 and 62.8 ± 17.1 , respectively, at an average of 34 months from the time of injury. Patients with normal DASH (≤ 10) and ASES (> 92) scores were younger than those with abnormal scores. At final assessment, 77% of the patients were currently working, with nine patients performing manual labor.

Conclusion: Following nonsurgical management of type V AC injuries, most patients are able to return to work but have limited functional outcome scores. A small subset of patients with type V AC injuries can achieve normal functional outcomes with nonsurgical management.

Level of Evidence: Level IV, Case Series

Acromioclavicular (AC) injuries are among the most common shoulder injuries encountered by orthopaedic surgeons.¹ A major challenge in treating AC injuries is determining the necessity of surgical intervention. Types I and II AC injuries, as defined by the Rockwood classification system, are universally treated nonsurgically, whereas most surgeons recommend surgical intervention for types IV, V, and VI.²⁻⁴ Treatment of type III injuries remains controversial; most surgeons advocate for a trial of nonsurgical management, whereas others recommend

surgical intervention, particularly for overhead athletes and laborers.^{3,5-7} Schlegel et al⁸ demonstrated that nonsurgical management of type III injuries resulted in favorable subjective outcomes in 16 of 20 patients (80%). Similarly, a recent meta-analysis comparing surgical and nonsurgical management of type III AC injuries demonstrated no substantial differences in strength, pain, throwing ability, and incidence of AC joint arthritis.⁹

Although nonsurgical management may be successfully used for type III injuries, the consensus from the orthopaedic surgery community generally

suggests that types IV through VI injuries should be repaired surgically unless comorbid factors preclude a patient from surgery.²⁻⁴ This recommendation is largely based on expert opinion because of a paucity of data investigating functional outcomes following nonsurgical management of types IV through VI AC injuries.

In this study, our primary objective was to determine the functional outcomes of type V AC injuries treated nonsurgically. Our secondary objective was to identify injury and patient characteristics that lead to improved functional outcomes. We hypothesized that younger patients, nonlaborers, and patients with injuries sustained to the nondominant extremity would have higher functional outcome scores.

Methods

Institutional Review Board approval was obtained for this study. A registry containing all patients presenting to the Los Angeles County+USC Medical Center, a level I trauma center, between January 1, 2010 and January 1, 2015 was analyzed retrospectively to identify patients for study inclusion. Inclusion criteria consisted of skeletally mature patients with type V AC injuries with ≥ 6 months of nonsurgical management that included a short period of immobilization and then physical therapy for shoulder range of motion, periscapular stabilization, and strengthening exercises. Exclusion criteria included patients with ipsilateral upper extremity fractures or concomitant soft-tissue injuries (ie, rotator cuff tears, labral injuries), those with metabolic bone disease, surgical reconstruction, or inadequate documentation, and skeletally immature patients. To be eligible, patients must have been evaluated by the orthopaedic service, either in the emergency department or the clinic, and have had radiographic and physical examination findings that are consistent with a type V AC injury.

Table 1

Rockwood Classification System of Acromioclavicular Joint Injuries

Type	AC Ligaments	CC Ligaments	Deltotrapezial Fascia	CC Distance Increase
I	Sprained	Intact	Intact	Normal (8.1 mm)
II	Torn	Sprained	Intact	<25%
III	Torn	Torn	Disrupted	25% to 100%
IV	Torn	Torn	Disrupted	Increased
V	Torn	Torn	Disrupted	>100%
VI	Torn	Torn	Disrupted	Decreased

AC = acromioclavicular, CC = coracoclavicular

Type V AC injuries were defined using the Rockwood classification system¹⁰ (Table 1). Type V AC injuries are classified as complete ruptures of the AC and coracoclavicular (CC) ligaments, as well as disruptions of the AC joint capsule and the deltotrapezial fascia. On AP radiographs, the CC distance is $>100\%$ of the contralateral side, with translation of the distal clavicle superiorly (Figure 1). Radiographic imaging series of the shoulder and clavicle were obtained for all patients. The initial Rockwood classifications were determined by the patient's radiographic and physical examination findings at the time of presentation. The radiographs of all eligible patients were subsequently reviewed by two blinded, board certified orthopaedic shoulder surgeons (G.F.H., R.O.). To be included in the study, both reviewers must have independently designated the injuries as type V per the Rockwood classification system.

Per protocol, all patients with type V AC injuries were initially counseled about the risks, benefits, and alternatives to surgical fixation for their injury, and if desired, were placed on the surgical scheduling list for elective AC reconstruction. All patients were treated with a short period of sling immobilization for 1 to 3 weeks and were referred to physical therapy for shoulder range of motion, periscapular stabilization, and strengthening exer-

Figure 1



AP radiograph of the shoulder demonstrating a type V acromioclavicular injury (coracoclavicular distance = 32.69 mm).

cises. Patients were then transitioned to a home exercise program when deemed appropriate by the physical therapist. Reasons for the choice of nonsurgical management of these injuries included patient preference (18%), lack of elective operating room availability (68%), and psychosocial factors (14%), such as failure to comply with follow-up appointments, incarceration, and drug/alcohol abuse.

Patient demographics, including age, hand dominance, tobacco use, occupation, as well as injury factors, such as mechanism, and time from injury to assessment were recorded. Radiographic measurements (ie, CC distance) were obtained at the time of

Table 2

Patient Characteristics	
Factor	Outcome
Sex	21 male, 1 female
Mean age at time of injury	42.2 ± 12.8 years
Dominant extremity injured	12 yes, 11 no
Manual laborer	9 yes, 13 no
Mean CC distance at time of presentation	26.3 ± 5.2 mm (+199%)
Mean change in CC distance at last follow-up	-7.2 ± 4.2 mm
Mean time from injury to assessment	34.3 ± 16.9 months

CC = coracoclavicular

Table 3

American Shoulder and Elbow Surgeons and Disabilities of the Arm, Shoulder, and Hand Scores Based on Patient Factors				
Factor	DASH (N)	P Value	ASES (N)	P Value
Injured Extremity				
Dominant	27.6 ± 18.5 (12)	0.956	61.6 ± 15.9 (12)	0.747
Nondominant	28.0 ± 17.6 (10)		64.0 ± 19.2 (10)	
Age				
<40 years	18.6 ± 18.8 (8)	0.088	72.7 ± 20.5 (8)	0.079
>40 years	33.0 ± 15.4 (14)		57.1 ± 12.3 (14)	
Laborer				
Yes	18.5 ± 17.2 (9)	0.045	70.2 ± 15.0 (9)	0.086
No	34.1 ± 15.7 (13)		57.7 ± 17.1 (13)	

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

presentation and at last follow-up. All patients were contacted by a trained research assistant, and functional scores were generated using two verified measures: Disabilities of the Arm, Shoulder, and Hand (DASH)¹¹ and American Shoulder and Elbow Surgeons (ASES).¹² Univariate analyses were performed to identify potential factors associated with improved functional outcome scores. A Student *t*-test was used for statistical analysis, with significance set at $P < 0.05$.

Results

Our study identified 47 patients with type V AC injuries over the 5-year

period, of which 22 met the inclusion criteria and were treated with at least 6 months of nonsurgical management. The cohort consisted of 21 men and 1 woman, with a mean age of 42.2 ± 12.8 years (range, 21 to 61 years) at the time of injury. All injuries were secondary to a direct blow to the shoulder. The injuries most frequently resulted from bicycle accidents, assault, or falls as seen in the Appendix (Supplemental Digital Content 1, <http://links.lww.com/JAAOS/A5>). Seven of 22 patients (32%) were active tobacco users. The mean CC distance at the time of presentation was 26.3 mm or +199% of the contralateral extremity. Eighteen of 22 patients (94%) with serial radiographs had a decrease in

CC distance at final follow-up. The mean difference in CC distance at the time of last follow-up was -7.2 ± 4.2 mm (range, -13.3 to 1.0 mm) at an average of 7.7 months from the initial radiographs (Table 2).

The average time from injury to assessment of functional outcome was 34.3 ± 16.9 months (range, 6 to 65 months). The mean DASH score was 27.8 ± 17.7 (range, 4.2 to 59.5) and mean ASES score was 62.8 ± 17.1 (range, 31.7 to 95.0). Of the 22 patients, 5 (23%) had a normal DASH score (≤ 10), and 2 (9%) had a normal ASES score (>92). Patients with normal DASH scores were younger (mean age, 32.5 ± 9.1 years) than those patients with abnormal scores (mean age, 45.1 ± 12.5 years), and their average time from injury to assessment was 39.5 months. Patients with normal ASES scores were also younger (mean age, 28.8 ± 2.6 years) than those with abnormal scores (mean age, 43.6 ± 12.6 years), and their average time from injury to assessment was 38.8 months. Functional outcomes in patients aged <40 years were better than those aged >40 years at the time of injury for both DASH ($P = 0.088$) and ASES ($P = 0.079$) scores (Table 3). The Pearson correlation coefficients between age versus DASH scores and age versus ASES scores were $R = 0.36$ and $R = -0.42$, respectively (Figures 2 and 3).

At the time of assessment, 17 of 22 patients (77%) were currently working, with 9 patients (41%) performing manual labor. All patients who were working at the time of injury had returned to work at the time of assessment. Four patients were unemployed and one was retired at the time of injury and assessment. Patients with an occupation in manual labor had lower DASH scores ($P = 0.045$) and higher ASES scores ($P = 0.086$) compared with nonlaborers. Of note, manual laborers were substantially younger with an average age of 35.5 ± 12.1 years versus an average

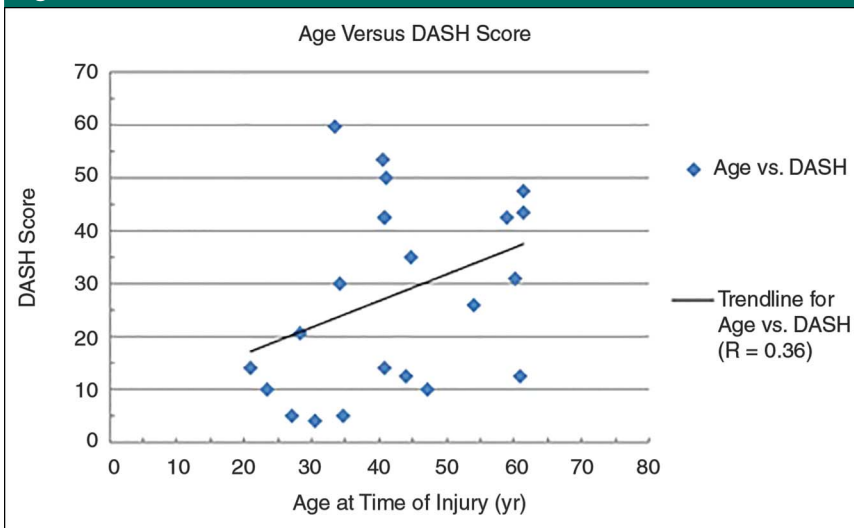
age of 45.7 ± 12.8 years for non-laborers ($P = 0.048$). There were no marked differences in functional outcomes related to hand dominance, tobacco use, time from injury to assessment, or CC distance.

Discussion

To our knowledge, this is the largest case series examining functional outcomes of purely type V AC injuries treated without surgery. Our study finds that most patients with type V AC injuries treated without surgery do not achieve normal functional outcomes. However, our study identified a small subset of patients (9% to 23%) who achieved normal functional outcome scores with physical therapy alone. Nearly all published recommendations call for surgical intervention for the management of Rockwood type V AC injuries, but little research has been performed on the nonsurgical functional outcomes of these injuries.^{2-5,10,13,14} Natural progression studies are crucial to the decision-making process involved with surgical intervention, as seen in the paradigm shift toward nonsurgical management of type III AC injuries.

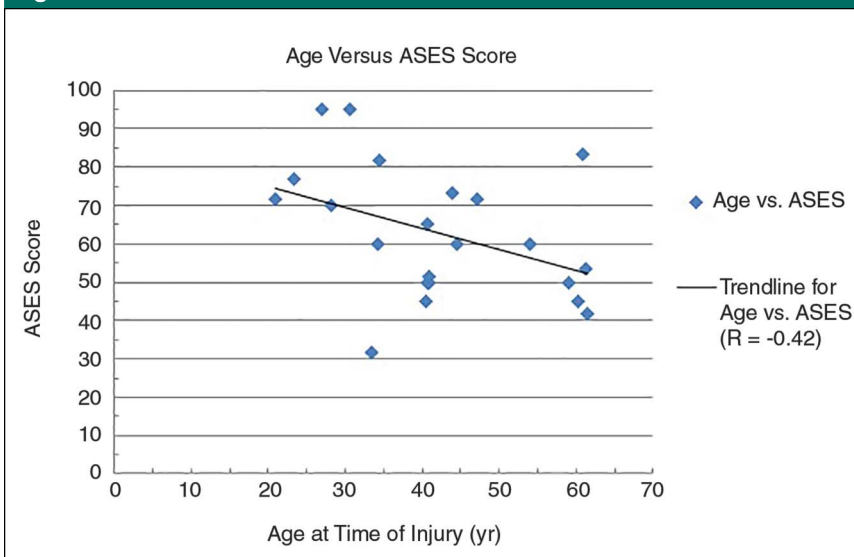
Several studies have examined the functional outcomes of nonsurgical versus surgical management of type III AC injuries, with attention toward return to sport and work.^{6,9,14} Phillips et al¹⁴ demonstrated in their meta-analysis that patients with type III AC dislocations treated with nonsurgical management returned to work sooner and had fewer sick days than those treated with surgery. Similarly, in a comparison of surgical and nonsurgical management of type III AC injuries, Smith et al⁹ reported that patients managed nonsurgically had fewer days of sick leave and no difference in strength, pain, and throwing ability compared with those who were managed sur-

Figure 2



Scatter plot graph demonstrating age versus Disabilities of the Arm, Shoulder, and Hand (DASH) score.

Figure 3



Scatter plot graph demonstrating age versus American Shoulder and Elbow Surgeons (ASES) score.

gically. In a recent randomized controlled trial that compared types III, IV, and V AC injuries treated with hook plate fixation versus physical therapy, nearly identical DASH scores were seen at 2 years for both surgical (DASH = 5) and nonsurgical interventions (DASH = 6).¹⁵ This

level I study did not quantify the number of type III versus type V injuries included in each group, thus making conclusions difficult on purely type V injuries. In addition, a small randomized controlled trial with an 18-year follow-up showed no substantial difference in functional

outcomes between surgical and nonsurgical management of both type III and type V injuries.¹⁶ These recent findings help support the need for research regarding the nonsurgical management of purely type V injuries.

We chose to analyze the functional outcomes of nonsurgical management of type V AC injuries with the DASH and ASES scores because they are validated measures of shoulder function that can be applied to a wide range of patients.^{11,12,17} In addition, the DASH and ASES scores have been widely used in previous studies and they allow for easy comparison with our series. Hunsaker et al¹⁸ reported that the normal value for the DASH score in the general population is 10.1 with a standard deviation of 14.68. Similarly, Sallay and Reed¹⁹ showed that the normal ASES score in the asymptomatic population was 92.2 with a standard deviation of 14.5. Little data are currently available on the functional scores after nonsurgical management of type V injuries. On a whole, the functional outcome scores in our patients were moderate, with average DASH and ASES scores of 27.8 and 62.8, respectively, at an average of 34 months from injury. Five of 22 patients (23%) had normal DASH scores (<10.1), and 10 of 22 (45%) were within one standard deviation of the normal score. For ASES scores, 2 of 22 patients (9%) had normal values (>92), and 4 of 22 (18%) were within one standard deviation. These numbers are slightly higher than previous functional assessments by Bannister et al,¹³ in which patients with severe AC dislocations (ie, >2 cm displacement) had 20% good or excellent results with nonsurgical management.

In the many studies reporting surgical outcomes of purely type V injuries, DASH and ASES scores are universally near normal ranges postoperatively. Virtanen et al²⁰ examined type V injuries in 50 patients treated with Kirschner wire fixation at >18 years

after surgery and found an average DASH score of 5.1. Similarly, Nicolas et al²¹ studied type V injuries treated with CC ligament reconstruction, and with a minimum 1-year follow-up, patients had an average ASES score of 96. Eschler et al²² published outcomes of hook plate fixation versus polydioxansulfate augmentation for type V injuries, and found DASH scores of 8 and 3.4, respectively, at an average 31-month follow-up. Although surgery offers excellent functional outcomes for most patients, surgical complications of type V AC injuries are well documented in the literature, with overall complication rates of up to 30%.⁵ Virtanen et al²³ published a study on a cohort of 25 patients with type V injury treated with CC reconstruction, and although the average DASH score was 14 at 4-year follow-up, 11 patients had clinically unstable AC joints, 14 had evidence of osteolysis, 3 had clavicle fractures, and 2 had wound infections. Eschler et al²² found an 18.5% rate of acromial osteolysis and a 7% rate of superficial wound infections requiring revision surgery after type V reconstruction with hook plates. These high rates of complications have economic, physical, and psychological effects on the patient. Thus, the surgeon must determine whether surgical intervention for patients with a type V AC injury warrants the risk of potential serious health problems and costs associated with surgical complications.

One of the most crucial determinants of whether or not to offer surgery is the classification of an AC injury as type III versus type V, which is largely determined by the CC distance found on AP radiographs.³ The interobserver and intraobserver reliability of the Rockwood classification has been shown to be good to excellent in distinguishing type III injuries from type V.²⁴⁻²⁶ The normal CC distance is 8 ± 0.17 mm, whereas type III injuries are classified by an

increase of 25% to 100% in CC distance and type V injuries are classified by a CC distance of >100%.^{10,27} The assumption is that in type III injuries, the lower CC distance allows for healing, whereas the larger CC distance in type V injuries does not.

Many studies of type V AC injuries have identified preoperative and postoperative CC distances, but there is little information about the natural progression of CC distance in nonsurgical management. In type V injuries, surgical treatment has been shown to reliably reduce or even overreduce the CC distance, but recent studies have shown that an interval increase in CC distance over time develops in a large number of these patients.^{15,20-23,28-30} An interval increase in CC distance has been shown to occur in some form, regardless of surgical technique, and has been demonstrated with tightrope, Kirschner wire, hook plate, and ligament reconstructions.^{15,20-23,28-30} Scheibel et al²⁹ published a series on 28 patients with type V AC injury treated with arthroscopic tightrope reconstruction of the AC and CC ligaments. At 2-year follow-up, the cohort had good clinical results but >40% of patients had radiographic evidence of recurrent instability. Similarly, in the study by Eschler et al,²² 10% of patients had complete loss of reduction (ie, CC distance >100%) and 8% had partial loss of reduction postoperatively. Surprisingly, these results did not correlate to worse clinical outcomes. In our study we examined the natural progression of CC distance from the time of presentation to last follow-up. Unlike patients treated surgically, no patient in our series achieved a normal CC distance with nonsurgical management; however, 94% of our patients had a decrease in CC distance at final radiographic follow-up, with the CC distance decreasing by an average of 7.2 mm over a mean period of 7.7 months. This finding suggests type V AC injuries have the

potential to partially reduce without surgery, similar to type III injuries.

Our study demonstrated that some patients with type V AC injury achieve normal functional outcome scores with nonsurgical management at nearly 3 years from injury. We attempted to identify prognostic factors (eg, age, hand dominance, occupation, CC distance) that correlated to improved functional outcomes. In our patients, occupation as a laborer led to significantly better DASH scores at the time of assessment ($P = 0.045$). ASES scores were also better for laborers but did not reach significance ($P = 0.086$). Other than occupation, all other prognostic factors tested did not substantially lead to improved functional outcome scores. We noted a trend toward improved DASH and ASES scores with younger age at the time of injury. In addition, we analyzed the five patients with normal DASH scores on assessment; their average age of 32.5 years was significantly younger than the average age of 45.1 years for the abnormal DASH score group ($P = 0.036$). The same was true for those patients with normal ASES scores. Likewise, the nine patients performing manual labor were significantly younger than the nonlaborers. Although we do not have direct physical assessments at time of follow-up, we can infer by the ability to maintain employment in manual labor that these nine patients have recovered adequate shoulder strength, range of motion, and endurance. We propose the improved functional outcome scores are potentially the result of an increased ability to strengthen and rehabilitate the injured shoulder in younger patients.

Our study was successful in identifying and assessing the functional status of a unique subset of shoulder patients, but given its reliance on retrospective and questionnaire data, it has several limitations. Patients were identified with a chart and radiology database search, with all initial clinical

information being gathered from consultation and clinic notes. Because of the limitations of our county health system, we were unable to bring all patients to the clinic for a complete standardized functional assessment at the time of presentation and follow-up. The incorporation of physical examination testing (eg, Constant score) may have provided a more accurate assessment of true shoulder function. Furthermore, the inclusion of a surgical group in this population would have significantly strengthened our study; however, because of the limited availability for elective cases at our hospital system, very few type V injuries are treated surgically. Like many studies in this population of patients, the small size of our cohort makes prognostic factors and statistical conclusions difficult to assess accurately. For example, we observed that patients with normal DASH and ASES scores were significantly younger than those with abnormal scores, but with an $n = 5$ and $n = 2$, respectively, a larger sample size is needed before accurate guidelines can be published on age cut-offs for the nonsurgical management of these injuries. An additional limitation to our study was that our nonsurgical intervention did not have a predetermined period of immobilization or physical therapy protocol. Each patient was treated on a case-by-case basis, with physical therapists determining home versus formal regimens for each patient. Although this represents “real world” medicine, the lack of a uniform nonsurgical treatment algorithm makes it more difficult to assess why some patients had better functional outcomes than others. Lastly, functional assessments were performed at one time point; if the data of the Canadian Orthopaedic Trauma Society are accurate, the expectation would be to see continued improvement in DASH and ASES scores over the first 2 years from the time of injury.¹⁵ This may have led to

an underrepresentation of the functional outcomes of the patients assessed at <2 years from injury.

Summary

Our study helps illustrate the natural progression of type V AC injuries in patients who undergo nonsurgical management. Most patients with type V AC injury who are treated nonsurgically are able to return to work but have limited functional outcome scores. However, a small subset of patients can achieve normal functional outcome scores with nonsurgical management. Given the rarity of nonsurgical management of these injuries, it is difficult to assess why this subset has improved outcomes. Our data suggest that younger age may lead to higher functional outcome scores, but more studies are needed to confirm this theory. Our data are not intended to refute the current consensus that surgical reconstruction is the best treatment of these injuries; however, it does provide more information for surgeons and patients. Given the potential costs and risks of surgical intervention, further research on a nonsurgical management algorithm for type V AC injuries is warranted.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 13, 15, 24, and 26 are level I studies. References 9, 14, and 16 are level II studies. References 2-5, 7, 8, 10-12, 18, and 22 are level III studies. References 1, 6, 17, 19-21, 23, 25, and 28-30 are level IV studies.

References printed in **bold type** are those published within the past 5 years.

1. Chillemi C, Franceschini V, Dei Giudici L, et al: Epidemiology of isolated acromioclavicular joint dislocation. *Emerg Med Int* 2013;2013(2013):171609.

2. Beitzel K, Cote MP, Apostolakis J, et al: Current concepts in the treatment of acromioclavicular joint dislocations. *Arthroscopy* 2013;29(2):387-397.
3. Li X, Ma R, Bedi A, Dines DM, Altchek DW, Dines JS: Management of acromioclavicular joint injuries. *J Bone Joint Surg Am* 2014;96(1):73-84.
4. Simovitch R, Sanders B, Ozbaydar M, Lavery K, Warner JJ: Acromioclavicular joint injuries: Diagnosis and management. *J Am Acad Orthop Surg* 2009;17(4):207-219.
5. Cook JB, Tokish JM: Surgical management of acromioclavicular dislocations. *Clin Sports Med* 2014;33(4):721-737.
6. Gstettner C, Tauber M, Hitzl W, Resch H: Rockwood type III acromioclavicular dislocation: Surgical versus conservative treatment. *J Shoulder Elbow Surg* 2008;17(2):220-225.
7. Petri M, Warth RJ, Greenspoon JA, et al: Clinical results after conservative management for grade III acromioclavicular joint injuries: Does eventual surgery affect overall outcomes? *Arthroscopy* 2016;32(5):740-746.
8. Schlegel TF, Burks RT, Marcus RL, Dunn HK: A prospective evaluation of untreated acute grade III acromioclavicular separations. *Am J Sports Med* 2001;29(6):699-703.
9. Smith TO, Chester R, Pearse EO, Hing CB: Operative versus non-operative management following Rockwood grade III acromioclavicular separation: A meta-analysis of the current evidence base. *J Orthop Traumatol* 2011;12(1):19-27.
10. Rockwood C, Green D: *Fractures in Adults*, ed 2. Philadelphia, PA, J.B. Lippincott, 1975.
11. Hudak PL, Amadio PC, Bombardier C; The Upper Extremity Collaborative Group (UECG): Development of an upper extremity outcome measure: The DASH (disabilities of the arm, shoulder and hand). *Am J Ind Med* 1996;29(6):602-608.
12. Michener LA, McClure PW, Sennett BJ: American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, patient self-report section: Reliability, validity, and responsiveness. *J Shoulder Elbow Surg* 2002;11(6):587-594.
13. Bannister GC, Wallace WA, Stableforth PG, Hutson MA: The management of acute dislocation a randomised prospective controlled trial. *J Bone Joint Surg Br.* 1989;71:848-850.
14. Phillips AM, Smart C, Groom AF: Acromioclavicular dislocation: Conservative or surgical therapy. *Clin Orthop Relat Res* 1998;353:10-17.
15. Canadian Orthopaedic Trauma Society: Multicenter randomized clinical trial of nonoperative versus operative treatment of acute acromio-clavicular joint dislocation. *J Orthop Trauma* 2015;29(11):479-487.
16. Joukainen A, Kroger H, Niemitukia L, Makela A, Vaatainen U: Results of operative and nonoperative treatment of Rockwood types III and V acromioclavicular joint dislocation. *Orthop J Sports Med* 2014;2(12):1-9.
17. Clarke MG, Dewing CB, Schroder DT, Solomon DJ, Provencher MT: Normal shoulder outcome score values in the young, active adult. *J Shoulder Elbow Surg* 2009;18(3):424-428.
18. Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B: The American Academy of Orthopaedic Surgeons Outcomes Instruments: Normative values from the general population. *J Bone Joint Surg Am* 2002;84(2):208-215.
19. Sallay PI, Reed L: The measurement of normative American Shoulder and Elbow Surgeons scores. *J Shoulder Elbow Surg* 2003;12(6):622-627.
20. Virtanen KJ, Remes VM, Tulikoura IT, et al: Surgical treatment of Rockwood grade-V acromioclavicular joint dislocations: 50 patients followed for 15-22 years. *Acta Orthop* 2013;84(2):191-195.
21. Nicholas SJ, Lee SJ, Mullaney MJ, Tyler TF, McHugh MP: Clinical outcomes of coracoclavicular ligament reconstructions using tendon grafts. *Am J Sports Med* 2007;35(11):1912-1917.
22. Eschler A, Gradl G, Gierer P, Mittlmeier T, Beck M: Hook plate fixation for acromioclavicular joint separations restores coracoclavicular distance more accurately than PDS augmentation, however presents with a high rate of acromial osteolysis. *Arch Orthop Trauma Surg* 2012;132(1):33-39.
23. Virtanen KJ, Savolainen V, Tulikoura I, et al: Surgical treatment of chronic acromioclavicular joint dislocation with autogenous tendon grafts. *Springerplus* 2014;3:420.
24. Gastaud O, Raynier JL, Duparc F, et al: Reliability of radiographic measurements for acromioclavicular joint separations. *Orthop Traumatol Surg Res* 2015;101(8 suppl):S291-S295.
25. Schneider MM, Balke M, Koenen P, et al: Inter- and intraobserver reliability of the Rockwood classification in acute acromioclavicular joint dislocations. *Knee Surg Sports Traumatol Arthrosc* 2016;24(7):2192-2196.
26. Cho CH, Hwang I, Seo JS, et al: Reliability of the classification and treatment of dislocations of the acromioclavicular joint. *J Shoulder Elbow Surg* 2014;23(5):665-670.
27. Väättäinen U, Pirinen A, Mäkelä A: Radiological evaluation of the acromioclavicular joint. *Skeletal Radiol* 1991;20(2):115-116.
28. Cook JB, Shaha JS, Rowles DJ, Bottoni CR, Shaha SH, Tokish JM: Clavicular bone tunnel malposition leads to early failures in coracoclavicular ligament reconstructions. *Am J Sports Med* 2013;41(1):142-148.
29. Scheibel M, Dröschel S, Gerhardt C, Kraus N: Arthroscopically assisted stabilization of acute high-grade acromioclavicular joint separations. *Am J Sports Med* 2011;39(7):1507-1516.
30. Verdano MA, Pellegrini A, Zanelli M, Paterlini M, Ceccarelli F: Modified Phemister procedure for the surgical treatment of Rockwood types III, IV, V acute acromioclavicular joint dislocation. *Musculoskelet Surg* 2012;96(3):213-222.