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Criteria for return to play after operative management of acromioclavicular joint separation: a systematic review

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Background: Acromioclavicular (AC) joint separation is a common cause of shoulder injury among athletes. High-grade injuries may require operative fixation, and comprehensive return-to-play guidelines have not yet been established. The purpose of this study was to summarize criteria for return to play after operative management of AC joint separation.

Methods: A systematic review of the literature was performed from January 1999 to April 2020 to evaluate clinical evidence regarding criteria for return to play after operative management of isolated AC joint separation.

Results: Sixty-three studies with at least 1 explicitly stated return-to-play criterion were identified out of an initial database search of 1253 published articles. Eight separate categories of return-to-play criteria were identified, the most common of which was time from surgery (95.2%). Return-to-play timelines ranged from 2 to 12 months, the most common timeline being 6 months (37.8%). Only 4 (6.3%) studies used conditional criteria to guide return to play, which included range of motion, strength, clinical stability, radiographic stability, functional assessment, safety assessment, and hardware removal.

Conclusion: Most published studies use only time-based criteria for return to play after surgery for AC joint separation, and only a small number of studies use additional subjective or objective criteria. While this systematic review helps provide a foundation for developing a comprehensive return-to-play checklist, further investigation is needed to establish safe and effective guidelines that will enable athletes to safely return to sport and minimize the recurrence of injury.

Acromioclavicular (AC) joint separations are among the most common shoulder injuries encountered in clinical practice and account for nearly half of all shoulder injuries sustained by contact sport athletes.[78] The Rockwood classification is the most commonly used system to aid with diagnosis and guide treatment of AC joint separations.[57] Lower grade injuries (Rockwood Types I and II) are typically managed nonoperatively, while surgeons have generally favored operative treatment for higher grade injuries (Rockwood Types IV – VI), although recent evidence suggests that nonoperative management may not be inferior to operative treatment for certain high-grade injuries.[11,15,30] Treatment of Rockwood Type III injuries remains controversial, although a trial of nonoperative management is favored in most cases.[63,67]

Various operative and nonoperative treatment regimens have been described to manage separation of the AC joint with the goal of improving shoulder function in both athletes and nonathletes.[3,15] For athletes, the ability to return to athletic competition is an important goal. Two recent systematic reviews reported high rates of return to play (>90%) after various techniques of surgical treatment of AC joint injuries.[28,71] However, despite the high incidence of AC joint injuries and the numerous methods of treatment used, there is no consensus among surgeons regarding when athletes may safely return to competition, particularly among contact and overhead athletes.

The purpose of this study is to systematically review existing literature to identify and describe criteria used to guide return to play after operative management of AC joint separations. We hypothesize that most surgeons use time-based criteria rather than functional criteria to guide return to play.

Methods

Search strategy

We performed a systematic review of Level I to IV studies that provided criteria for return to play after operative management of

Institutional review board approval was not required for this systematic review.

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AC joint separation using the PubMed, EMBASE, and Cochrane databases from January 1999 to April 2020. January 1999 was selected as 20 years before the inception of this investigation to include modern operative techniques of managing AC joint separations. The database search included various combinations of the following search terms: *acromioclavicular*, *AC joint*, *dislocation*, *separation*, *disruption*, *surgery*, *surgical*, *reconstruction*, *repair*, *stabilization*, and *outcome*.

Inclusion/exclusion criteria

To be included, studies were required to (1) be written in the English language, (2) be conducted on a population of patients with a mean age of 18 years or higher, (3) include patients who underwent operative treatment for acute or chronic AC joint separations, and (4) include patients with a minimum of 12 months of follow-up. Studies lacking explicit return-to-play criteria, review articles, case reports, biochemanical or cadaveric studies, and technical notes that reported cohorts of less than 5 patients were excluded. Studies in which greater than 10% of patients had concomitant injuries to the ipsilateral extremity or in which greater than 10% of patients underwent secondary management after failure of previous surgical treatment for AC joint separation were also excluded. Studies evaluating patients with chronic AC joint separation not previously treated surgically and patients who failed previous nonoperative treatment were included.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed throughout this review.[42] The initial screening of titles, abstracts, and manuscripts was completed by a team including a resident-physician, medical student, and orthopedic sports-medicine fellow (T.D., R.J.G., P.T.O.). Any disagreements were resolved by consensus between reviewers, and other questions regarding further inclusion or exclusion were directed toward the senior authors (M.G.C. and S.B.C.). The references of all studies satisfying inclusion criteria were manually reviewed to screen for any records not obtained during the database search.

Return-to-play criteria

We used the definition *return to play* as a general term referring to a return to full, unrestricted sporting activity after operative management of AC joint separations. Given the abundance of terms used to describe these criteria in the literature, we treated the following terms as equivalent unless the authors specified any additional surgeon-imposed restrictions on their patients: return to play, return to sport, return to athletics. In addition, given the desire to focus on athletes, any study that did not explicitly mention play, sport, or athletics (ie, instead mentioning only return to heavy lifting, work, unrestricted activity) was excluded from this analysis.

Patient demographics, outcomes, and surgical techniques

From each study satisfying the inclusion criteria, the primary data evaluated were criteria relating to return to sporting activity. Further abstraction included data regarding authors, year of publication, study level of evidence, classification of injuries (Rockwood, Tossy, and so on), average age of patient cohorts, sex distribution, level of athletics, types of sport played, rates of return to sport, changes in frequency, intensity, or level of athletic activity, and rehabilitation protocols. Because of the variability of study designs and the heterogeneity in the reporting of results, a comprehensive meta-analysis was not performed. Surgical techniques appearing in the studies were recorded, making note of the use of arthroscopy, the method of stabilization of the coracoclavicular and AC joints, and the use of grafts, sutures, and other materials.

Quality assessment of literature methodology

A modified version of the Coleman Methodology Score (CMS) was used to assess the methodological quality of included publications.[13] The CMS evaluates 10 separate criteria to yield a final score ranging from 0 to 100, with 100 being the highest methodological quality. Scores ranging from 85 to 100 are considered excellent, from 70 to 84 are good, from 55 to 69 are fair, and less than 55 are considered poor. When assessing diagnostic certainty of injury classifications, we considered any article that mentioned specific Rockwood classifications of subjects as having sufficient diagnostic certainty, regardless of whether the authors explicitly mentioned the use of radiographs or a focused physical examination for diagnosis. However, any study in which the authors explicitly stated that diagnoses were made without radiographs or a focused physical examination was considered to have insufficient diagnostic certainty, as per CMS criteria.

Results

Study design

The initial database search yielded 1253 unique published articles. Ultimately, 63 studies that satisfied all inclusion criteria were identified and included in the analysis. Detailed results of the literature review are described in the PRISMA diagram (Fig. 1). Regarding level of evidence for included studies, 2 studies were Level I, 3 studies were Level II, 4 studies were Level III, and 54 studies were Level IV.[81]

Quality assessment

The average CMS was 64.8 ± 9.5, which indicates fair methodological quality (Supplemental Table S1). CMS scores ranged from 29 to 85.[38,50,66] Principle methodological strengths among this cohort of studies include a description of postoperative rehabilitation, in which every study described a rehabilitation protocol to some extent, and a description of surgical technique, which received a score of 9.5 ± 1.5 (out of 10). Notable methodological limitations include type of study and overall study size, with these metrics receiving scores of 2.2 ± 4.7 and 2.4 ± 2.6 out of 15 and 10, respectively. Most studies were retrospective cohort studies or case reports (80.1%) with small cohorts. Only 8 studies (12.7%) included cohorts of greater than 50 patients, while 31 studies (49.2%) included cohorts of less than 30 patients.

Patient and study demographics

The 63 studies included 1939 patients. The mean age of subjects in individual studies ranged from 25.0 to 50.1 years, with an overall weighted mean age of 36.5 years. Of the 61 studies that reported sex distribution, 85.1% of patients were male. Patient follow-up ranged from 12 months to 106.3 months, with a weighted average follow-up duration of 33.9 months for the 58 studies that reported the mean follow-up time. Individual study data and demographic information for patients of included studies are detailed in Table I.

All but 3 studies explicitly mentioned whether patients were treated for acute or chronic AC joint separations.[1,26,80] Forty-seven studies evaluated patients who were treated for only acute injuries, 9 studies evaluated patients with only chronic injuries, and 4 studies included patients with both acute and chronic injuries.

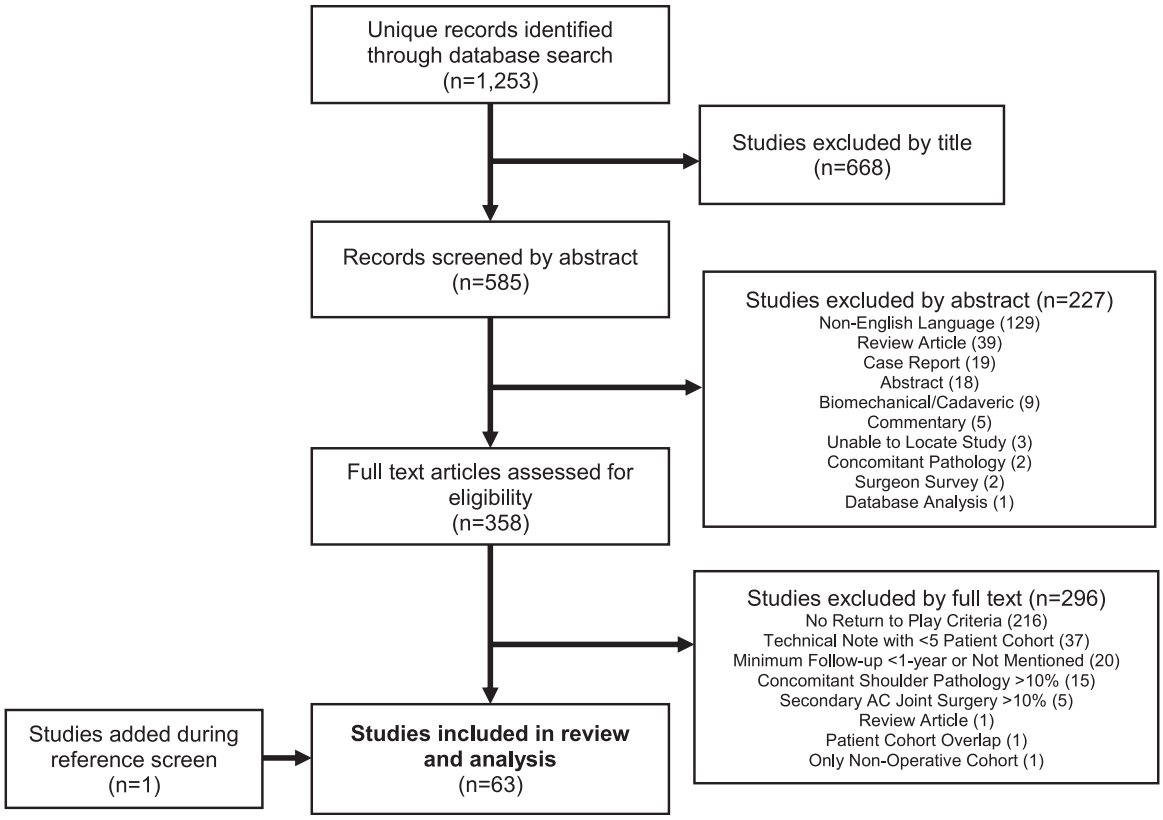

Figure 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram of search strategy.

Sixty-one studies reported the classifications of AC joint separations. The most common injury classification groupings included cohorts with Rockwood Types III/IV/V injuries (38.1%), Rockwood Types III/V injuries (19.0%), and Rockwood Type V injuries alone (14.3%). Additional combinations of injury classifications are demonstrated in Table II. Two studies did not specify the type of AC joint injury: One study[50] treated patients with acute "unstable ACJ injuries," and another study[61] treated patients with "acute AC dislocation." Two studies mentioned the type of Rockwood injuries included but did not specify the number of subjects in each group.[19,80]

Return-to-play criteria

All 63 studies reported at least 1 explicit criterion for return to play, and 60 studies (95.2%) reported only a single return-to-play criterion (Table III). A total of 8 separate criteria were reported: (1) time from surgery, (2) shoulder range of motion, (3) strength, (4) clinical stability of the AC joint, (5) radiographic stability of AC joint, (6) functional assessment, (7) safety assessment, and (8) hardware removal. Time from surgery was the most frequently cited criterion guiding return to play (95.2%) and was the sole criterion in 59 of the 63 studies (Table III).

The most frequently cited timeframe from surgery to return to sport was 6 months in 23 studies, followed by 3 months in 18 studies (Table IV). Return-to-play timelines ranged from 2 months to 12 months after surgery. In addition to the explicit return-to-play criteria, all 63 studies did describe some form of postoperative rehabilitation, although no studies used completion of a rehabilitation program as a criterion for return to sport. Immobilization and range of motion guidelines were the most commonly reported rehabilitation points of interest (95.2% and 93.7%, respectively), followed by strengthening exercises (44.4%) and arm elevation restrictions (36.5%).

Sport participation and return to sport outcomes

Twenty-three studies (36.5%) reported the number of athletes included, representing a total of 594 athletes. An additional 281 athletes were inferred from 24 other studies (38.0%) based on a sports-related mechanism of injury, but these studies did not explicitly mention the total number of athletes among their patient cohorts. Sixteen studies (25.4%) did not mention the number of athletes either explicitly or in their mechanism of injury. Twenty-four studies (38.0%) reported the sports in which patients participated before injury. Among the 36 sports represented, the most frequently reported types of athletes were cyclists in 15 studies (23.8%), soccer players in 10 studies (15.9%), basketball players in 6 studies (9.5%), and skiers or snowboarders in 5 (7.9%) studies. The level of sports in which patients participated was explicitly referenced in 9 studies, accounting for 231 patients. Among these were 38 professional athletes (16.5%), 7 semi-professional athletes (3.0%), 21 nonprofessional athletes (9.1%), 20 competitive athletes (8.7%), and 145 recreational athletes (62.8%).

The rate of return to play was reported in 19 studies (Fig. 2). Among these, 94.2% of athletes returned to some level of athletics regardless of whether athletes regained their preinjury level of performance (range 72.4% to 100%). Seventeen studies specifically reported that patients returned to their preinjury level of performance or higher at a rate of 81.1% (range 50% to 100%). Nine studies described changes in the level of sports participation after treatment compared with the preinjury level.

Table I
Individual study data including injury classification, demographic data, and return-to-play criteria.

First author, yr	Injury classification* (no.)	Primary stabilization method(s)	Level of evidence	No. of patients	Mean age in years	Mean follow-up in months (minimum)	No. of RTP criteria†	RTP criteria†
Abat, 2018[1]	3/3/14	Arth CC suture button	IV	20	36.1	25.4 (18.5)	1	Time
Barth, 2015[2]	10/6/8	Arth CC suture button, Weaver-Dunn, combined Weaver-Dunn and CC reconstruction with soft-tissue graft, combined suture button and CC reconstruction with soft-tissue graft, CC reconstruction with LARS artificial ligament	IV	24	41	12 (12)	1	Time
Beris, 2013[4]	8/4/0	Open CC suture button	IV	12	27.5	18.25 (12)	1	Time
Boutsiadis, 2016[5]	0/1/4	Arth combined Waver-Dunn with suture button and AC and CC reconstruction with palmaris autograft	IV	5	37	18 (18)	1	Time
Breuer, 2019[6]	8/11/32	Open CC suture button and AC suture reconstruction	IV	51	43‡	55 (29)‡	1	Time
Cano-Martinez, 2016[7]	0/0/33	Open CC suture button	IV	33	25	25 (14)	1	Time
Cardone, 2002[8]	6/0/0	Open CC suture fixation	IV	6	26.7	44.8 (31)	1	Time
Carkci, 2020[9]	14/0/22	Arth CC suture button	IV	36	30.6	31.4 (24)	1	Time
Carrera, 2013[10]	7/3/11	Open CC suture anchor repair and clavicular pinning	IV	21	35	18 (13)	1	Time
Cho, 2016[12]	4/12/20	Open CC suture button with AC K-wire stabilization or clavicular pinning	IV	36	40.8	56.7 (24)	1	Time
Dal Molin, 2017[16]	0/3/17	Open CC screw with CC suture fixation	IV	20	34.8	45 (24)	1	Time
De Carli, 2015[17]	30/0/0	Open CC suture button	IV	30	29.2	42 (24)	1	Time
Dimakopoulos, 2006[18]	24/0/10	Open CC suture fixation	IV	34	33.5	33.2 (18)	1	Time
El Shewy, 2011[19]	RW IV-V†	Open CC suture fixation	IV	21	31.8	92.4 (72)	1	Clinical AC joint stability; radiographic AC joint stability
Gangary, 2016[20]	6/2/3	Arth CC suture button	IV	11	34.2	12 (12)	1	Time
Garofalo, 2017[21]	0/0/32	Open semitendinosus autograft reconstruction of CC and AC	IV	32	28	30 (24)	1	Time
Gomez-Vieira, 2009[23]	2/5/3	Arth CC suture button	IV	10	34	15 (12)	1	Time
Greiner, 2009[24]	5/1/44	Open CC suture fixation	IV	50	35.3	70 (30)	1	Time
Hashiguchi, 2018[25]	8/0/4	Arth CC reconstruction with Leeds-Keio artificial ligament and AC K-wire stabilization	IV	12	40.8	106.3 (62)	3	Time; ROM; strength
Hou, 2014[26]	1/1/18 1 RW VI	Open semitendinosus allograft reconstruction of CC, combined semitendinosus allograft with suture button	IV	21	39.4	15.5 (12)	1	Time
Katsenis, 2015[27]	0/29/21	Open CC suture button	IV	50	35.5	42 (36)	1	Time
Kocaoglu, 2017[29]	25/4/2 1 RW VI	Open CC suture button with modified Weaver-Dunn; CC reconstruction with palmaris longus autograft and suture button	III	32	39.7	44.9 (29)	1	Time
Kurtoglu, 2020[31]	12/0/13	Open CC suture button	IV	25	30.7	18.6 (12)	1	Time
Läuderman, 2011[32]	6/12/19	Open CC suture fixation with AC joint suture reconstruction	IV	37	33.6	54 (24)	1	Time
Lee, 2019[34]	12/0/15	Arth CC all suture anchor repair	IV	27	35.2	N/M (24)	1	Time
Leidel, 2009[35]	70/0/0	Open AC K-wire stabilization	IV	70	37	48 (24)	1	Time
Li, 2013[36]	0/7/3	Arth CC suture button with AC suture anchor fixation	IV	10	46.4	33.6 (24)	1	Time
Liu, 2015[37]	7/0/5	Arth CC suture button	IV	12	48	24 (18)	1	Time
Lu, 2016[38]	66/11/3	Open CC suture button	II	80	33.9	25.4 (12)	1	Time
Metzlaff, 2016[41]	RW III-V†	Open hook plate; CC suture button	III	44	37.6‡	32 (24)‡	1	Time
Motta, 2012[43]	38/11/2	Open CC reconstruction with LARS artificial ligament	III	51	36	60 (24)	1	Time
Muccioli, 2016[40]	23/5/15	Open CC reconstruction with LARS artificial ligament	II	43	29‡	28.2 (24)	2	Strength; functional assessment; safety assessment
Müeller, 2018[46]	12/6/43	Open hook plate; Arth CC suture button	I	61	36.1	N/M (24)	1	Time
Muench, 2019[45]	20/0/23	Open CC and AC reconstruction with semitendinosus or peroneus longus allograft	IV	43	43.4	40.8 (24)	1	Time
Murena, 2013[47]	34/0/0	Open CC screw fixation; Arth CC screw fixation; Arth CC suture button	IV	34	41.8	82.7 (50.4)	1	Time
Murray, 2018[48]	18/11/0	Open CC suture button	I	29	31	12 (12)	1	Time
Natera-Cisneros, 2015[50]	N/M	Arth CC suture button plus AC suture reconstruction	IV	9	N/M	N/M (12)	1	Time
Natera-Cisneros, 2017[49]	5/0/6	Open hook plate	IV	11	41	32.5 (24)	1	Time
Parnes, 2015[52]	0/0/12	Arth CC and AC reconstruction with semitendinosus autograft or allograft	IV	12	25	30.4 (24)	1	Time
Porschke, 2017[53]	0/0/55	Open CC suture button	IV	55	42	24 (18)	1	Time
Porschke, 2019[54]	5/0/49	Open CC suture button	IV	54	41.5	23 (18)	1	Time
Ranne, 2020[55]	29/0/29	Arth CC reconstruction with semitendinosus autograft	IV	58	36.4	N/M (24)	1	Time
Saccomanno, 2014[58]	8/4/6	Open CC and AC reconstruction with semitendinosus autograft	IV	18	27.5	26.4 (24)	1	Time
Saier, 2016[59]	0/0/42	Arth CC suture button	IV	42	34.5	31.3 (24)	1	Time
Sandmann, 2012[60]	9/9/15	Open CC suture fixation and AC suture reconstruction	IV	33	39	32 (24)	1	Time
Seo, 2019[61]	N/M	Arth CC suture button	III	32	50.1	13.7 (12)	1	Time
Shin, 2009[62]	0/0/29	Open CC suture anchor with CA ligament transfer	IV	29	39.7	27.8 (24)	1	Time

(*continued on next page*)

Table I (*continued*)

First author, yr	Injury classification* (no.)	Primary stabilization method(s)	Level of evidence	No. of patients	Mean age in years	Mean follow-up in months (minimum)	No. of RTP criteria†	RTP criteria†
Steinbacher, 2014[64]	19/0/0	Open clavicular hook plate	IV	19	29	50.4 (22.8)	1	Time
Struhl, 2015[65]	19/2/14	Open CC suture button with CC repair or CA ligament transfer	IV	35	42.4	62.4 (27)	1	Time
Sun, 2019[66]	46/23/11	Open CC suture button	II	80	35.4	34.5 (12)	1	Time
Tiefenboeck, 2017[69]	13/4/2, 3 RW II	Open CC screw with AC K-wire stabilization	IV	22	41	93.6 (24)	1	Time
Tiefenboeck, 2018[68]	30/14/3	Open CC reconstruction with LARS artificial ligament	IV	47	37	89 (25)	1	Time
Triantafyllopoulos, 2017[70]	0/0/10	Open CC and AC reconstruction with JewelACL artificial ligament	IV	10	33	48 (24)	1	Time
Vitali, 2015[72]	29/6/2	Open CC reconstruction with GORE PROPATEN vascular graft and AC K-wire stabilization	IV	37	34.4	N/M (24)	1	Time
Vulliet, 2017[73]	21/0/19	Arth CC suture button	IV	40	38.2	26.1 (12)	1	Time
Wang, 2008[76]	0/0/13	Open CC suture fixation with AC pin stabilization	IV	13	28.3	55.2 (23)	1	Time
Wang, 2014[77]	18/0/3	Open clavicular hook plate with coracoid process transfer to clavicle	IV	21	41.6	33 (26)	1	Hardware removal
Wang, 2015[74]	0/0/0, 12 Tossy III	Open clavicular hook plate plus with AC and CC trapezius muscle flap	IV	12	36.1	22.83 (16)	1	Time
Wang, 2018[75]	6/2/8	Open clavicular hook plate; AC and CC reconstruction with flexor profundus tendon allograft	IV	16	45.2	30.3 (24)	1	Time
Wolf, 2004[80]	RW III-V†	Arth suture fixation with clavicular and coracoid tunnel liner screws	IV	21	N/M	24 (12)	1	Time
Xue, 2018[82]	0/0/25	Open CC suture button	IV	25	43	34 (24)	1	Time
Ye, 2014[83]	14/2/26	Open CC titanium cables	IV	42	36	42 (34)	1	Time
Yoo, 2011[84]	3/0/10	Arth CC reconstruction with semitendinosus autograft	IV	13	28.4	17 (12)	1	Time

RTP, return to play; *RW*, Rockwood; *N/M*, not mentioned; *Arth*, arthroscopic; *CC*, coracoclavicular; *AC*, acromioclavicular; *ROM*, range of motion; *LARS*, Ligament Augmentation and Reconstruction System; *CA*, coracoacromial ligament.

*Injury classification documented as Rockwood III/IV/V unless otherwise mentioned.

†Median number.

‡Number of each classification not specified.

Surgical techniques

Fifty-two of the 63 studies (82.5%) used a single surgical technique. Nine studies (14.3%) reported on 2 surgical techniques while 2 studies (3.2%) included 3 or more techniques. Twenty-one studies (33.3%) reported the use of an arthroscopic-assisted technique. In all, 11 primary modes of stabilization, 9 of which involved reconstructing or repairing the coracoclavicular ligaments and 2 involved AC stabilization primarily, were identified, and 5 methods of auxiliary AC joint stabilization or augmentation were also identified and used in 27 studies (42.9%) (Table V). Twenty-six combinations of surgical techniques were identified, with the most commonly reported being suture button constructs without additional AC stabilization (18 studies, 28.6%). In looking at primary stabilization methods regardless of the utilization of auxiliary AC stabilization, the most frequently used surgical technique involved suture button constructs (28 studies, 44.4%), followed by suture constructs, soft-tissue graft constructs, artificial graft constructs (8 studies each, 12.7%), and hook plate stabilization (7 studies, 11.1%). The most frequently used auxiliary AC stabilization techniques involved soft-tissue graft reconstruction and suture repair (8 studies each, 12.7%). Fifteen techniques included combined coracoclavicular and AC joint stabilization, with the most frequently used being soft-tissue graft reconstruction of both joints (5 studies, 7.9%). With regard to distal clavicle excision, a Weaver-Dunn-type procedure was used in 4 studies (6.3%), and 7 studies (11.1%) used techniques that always, or sometimes, required a distal clavicle excision. A free soft-tissue graft was used in 11 studies (17.5%), while the coracoclavicular ligaments were repaired in 8 studies (12.7%). See Table V for further information.

Table II
Combinations of AC joint injury classifications included among the cohort of 63 studies.

Injury classifications	Studies, *n* (%)
RW III/IV/V	24 (38.1)
RW III/IV	2 (3.2)
RW IV/V	5 (7.9)
RW III/V	12 (19.0)
RW II/III/IV/V	1 (1.6)
RW III/IV/V/VI	2 (3.2)
RW III	5 (7.9)
RW V	9 (14.3)
Tossy III	1 (1.6)
N/M	2 (3.2)

RW, Rockwood; *N/M*, not mentioned.

Discussion

The results of this systematic review suggest that, despite the high incidence of AC joint injuries among athletes, return-to-play criteria remain insufficiently defined. Currently, no comprehensive guidelines for rehabilitation and return to sport have been recognized.

Return-to-play rates after management of AC joint separations are consistently high. Two recent systematic reviews evaluating return to sport outcomes after surgical treatment demonstrate return-to-play rates greater than 90%, which are consistent with

Table III
Combinations of criteria for return to play after operative management of AC joint separation in the cohort of 63 studies.

Combinations of criteria for return to play	Studies, *n* (%)
Time	59 (93.7)
Time, range of motion, strength	1 (1.6)
Clinical stability, radiographic stability	1 (1.6)
Strength, functional assessment, safety assessment	1 (1.6)
Hardware removal	1 (1.6)

Table IV
Summary of return-to-play timelines after operative management of AC joint separation among the 60 studies that cited return-to-play timelines.

Return-to-play timeline	Studies, *n* (%)
2 mo	1 (1.7)
3 mo	18 (30.0)
4 mo	5 (8.3)
4-5 mo	2 (3.3)
5 mo	2 (3.3)
4-6 mo	5 (8.3)
5-6 mo	1 (1.7)
6 mo	23 (38.3)
6-8 mo	1 (1.7)
10 mo	1 (1.7)
12 mo	1 (1.7)

our results.[28,71] Despite these high rates of return to play, the rates of reinjury and loss of reduction are not insignificant. While the incidence of reduction loss is largely dependent on variations in hardware implantation and surgical technique, several case series have demonstrated loss of reduction rates as high as 15% to 80%.[14,39,79] Premature progression through rehabilitation as well as patient noncompliance with postoperative activity limitations also contribute to loss of reduction and other complications that impede return to optimal athletic performance. For this reason, comprehensive criteria guiding progression through rehabilitation and return to sporting activities must be established.

In this systematic review, we identified 8 unique criteria for return to play after operative management of AC joint dislocations. These criteria can aid the creation of a checklist for return to play after AC joint stabilization surgery. As hypothesized, time from surgery was by far the most commonly reported criterion guiding return to play. Several studies reported other subjective or objective conditional criteria. However, only 1 study cited a functional return-to-play criterion associated with a specific measurement,[43] and none of the included studies described a well-defined series of criteria to guide return to play. In addition to explicit return-to-play criteria, we also analyzed rehabilitation protocols to determine which general factors surgeons favored during postoperative rehabilitation. Immobilization (95.2%) and range of motion guidelines (93.7%) were the most commonly cited rehabilitation points of interest, although adequate shoulder motion was explicitly cited as a return-to-play criterion in only one study analyzed in this review.[25]

In several instances, it was apparent that authors were cognizant of the demands that certain activities might place on the surgical repair. One study imposed restrictions on patients from specifically returning to competitive football matches, rather than athletics in general.[8] Two studies provided multiple tiers of return-to-play guidance with 2 different time points, both of which permitted athletes to return to "noncontact sports" at an earlier time point (3 or 4 months, respectively) and then removed all restrictions at 6 months.[16,54] All three of these studies were included in this analysis, and we considered the 6-month time point for both studies with a tiered return-to-play protocol.

Few studies used metrics other than time-based criteria to guide return to play. Only 1 study[19] used a radiographic return-to-play criterion, and no studies applied a validated scoring assessment to guide return to play. While infrequently used in the context of guiding return to play, these assessments can be considered for use in developing return-to-play guidelines; however, their utility for this purpose is not immediately clear.

In establishing comprehensive return-to-play guidelines, consideration may need to be given to the surgical technique because of the large number of techniques currently being used. Certain techniques involve implantation of hardware, such as AC hook plates, which need to be removed before a patient can return to unrestricted sporting activity.[33] Furthermore, the effects of other surgical factors (ie, open vs. arthroscopic procedures, autograft vs. allografts vs. other techniques) remain uncertain as they pertain to establishing return-to-play guidelines.

Lower grade AC joint injuries are generally treated nonoperatively.[44,51] In 1997, Gladstone et al[22] described a 4-phase rehabilitation protocol, which includes an immobilization period, a range of motion and strengthening period, a functional participation period, and a sports-specific training period. Despite this, return to play after nonoperative treatment of AC joint injuries is rarely the subject of investigation. While this systematic review did not formally assess criteria for return to play after nonoperative treatment of AC joint separations, we identified 4 studies with nonoperative patient cohorts that would have otherwise satisfied inclusion criteria for this review. Among these was one study that focused exclusively on nonoperative patients and three comparative studies of which patients in the operative cohort were included in this analysis. Two of these nonoperative cohorts based their return-to-play guidelines exclusively on time-based criteria,[48,56] while the remaining two studies each used a specific subjective

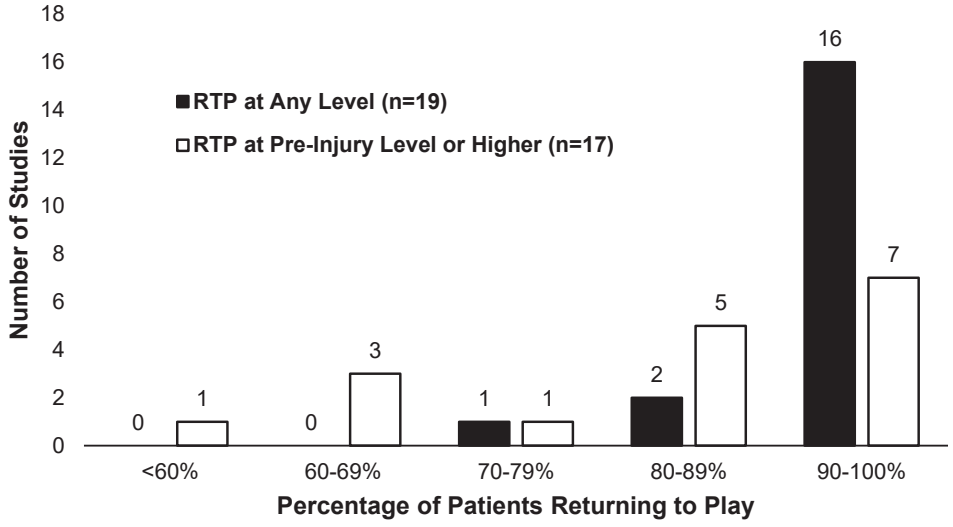

Figure 2 Rates of return to play after operative management of AC joint separation reported in the literature.

Table V
Number of studies using various surgical techniques.*

Technique	Studies	Technique	Studies
Primary stabilization method		Number of techniques described	
Suture button construct	28	1	52
Suture-only construct	8	2	9
Soft-tissue graft reconstruction	8	≥3	2
Synthetic graft	8		
Clavicular hook plate	7	Open surgical approach	44
Suture anchor	4	Arthroscopic assistance	21
Weaver-Dunn procedure	2		
Combined soft-tissue graft and suture button	3	Use of distal clavicle excision	
Coracoclavicular screw	3	No	58
Combined Weaver-Dunn and soft-tissue graft augmentation	2	Yes/Sometimes	7
Acromioclavicular pinning	1	Weaver-Dunn	3
Auxiliary acromioclavicular stabilization		Free soft-tissue graft utilization	
None	37	None	55
Reconstruction with soft-tissue graft	8	Autograft	6
Suture repair	8	Allograft	3
Pinning	7	Both or unclear source	2
Suture reconstruction	6		
Reconstruction with artificial graft	1	No coracoclavicular ligaments repair	58
		Coracoclavicular ligaments repaired	9

*Owing to several studies describing multiple techniques, values exceed the overall number of included studies.

criterion: when patients were "asymptomatic" and when patients "felt able" to return to their athletics.[8,49]

The main limitations of this investigation concern the inherent variability in the reporting of return-to-play criteria and the overall heterogeneity of study characteristics regarding surgical technique and treatment acuity. We only included studies that explicitly mentioned return to athletic activity and excluded studies that may have ultimately contained athletes who returned to sport. Similarly, authors may have provided their patients with return-to-play guidelines, such as completing a rehabilitation program, without explicitly reporting them in their final manuscripts. Owing to advancement in surgical techniques, we included only studies from the last 20 years, which may have limited our ability to identify additional criteria for return to play.

Conclusion

This systematic review revealed that criteria for return to play after operative management of AC joint separations remain insufficiently defined. Most published articles report exclusively time-based criteria, and no studies in this review offered detailed functional return-to-play guidelines. The results of this systematic review provide a foundation for developing a comprehensive return-to-play checklist. Further investigation is needed to establish specific and effective guidelines that will enable athletes to safely return to sport and minimize the recurrence of injury after operative management of AC joint separation.

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Supplementary Data

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