



Surgical management of chronic high-grade acromioclavicular joint dislocations: a systematic review

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Background: To date, no gold-standard technique exists for the treatment of chronic acromioclavicular joint (ACJ) instability. We systematically reviewed the clinical results of 3 main categories of ACJ reconstruction for high-grade chronic instability.

Methods: A literature search was performed according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. The inclusion criteria were clinical studies involving patients with ACJ instability (Rockwood grades III–VI) for at least 6 weeks, managed with ACJ stabilization, with a minimum 1-year follow-up. Depending on the surgical technique, patients were divided into 1 of 3 groups: nonbiological fixation between the coracoid and clavicle, for example, suture loops and synthetic ligaments (group 1); biological reconstruction of the coracoclavicular ligaments, for example, allograft or autograft ligament reconstruction (group 2); and ligament and/or tendon transfer, for example, the Weaver-Dunn procedure (group 3). Patient demographic characteristics, functional scores, radiographic outcomes, and complications were compared.

Results: Two independent investigators reviewed 960 articles. A total of 27 studies met the inclusion criteria, comprising 590 patients divided into 1 of 3 groups. The complication rates were similar among the 3 groups: 15% for nonbiological fixation, 15% for biological reconstruction, and 17% for ligament and/or tendon transfer, with failure rates of 8%, 7%, and 5%, respectively. In terms of functional results, the mean Constant score was 87.2 points for nonbiological fixation (n = 89), 92.4 points for biological reconstruction (n = 86), and 87.4 points for ligament and/or tendon transfer (n = 49).

Conclusion: On comparison of the results of 3 different ACJ reconstruction methods, all techniques showed similar complication rates. Among the level II studies, ACJ reconstruction with a tendon graft showed superior results.

Level of evidence: Level IV; Systematic Review

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Acromioclavicular (AC) joint injuries are among the most frequent injuries seen after direct trauma to the shoulder.²⁹ There is a general consensus throughout the literature to perform conservative management of low-grade AC joint injuries (Rockwood grades I and II), whereas symptomatic high-grade injuries (grades IV-VI) are routinely managed with surgical reconstruction to stabilize the AC joint.²⁵ However, controversy still exists regarding the treatment of grade III injuries, and decision making is often based on the individual's occupation and sporting activity. Surgical management is often recommended in patients at higher risk of failure of nonoperative management, such as manual workers or athletes who frequently engage in overhead movements.³¹ Recently, the Rockwood classification has been modified to distinguish between horizontally stable (grade IIIA) and unstable (grade IIIB) injuries, which aids in decision making.⁴

A large variety of operative treatment options exist for both acute and chronic AC joint instabilities.^{3,9,25,29,31} In acute higher-grade injuries (<6 weeks), the general principle is to reduce the AC joint to allow the coracoclavicular (CC) ligaments to heal. However, in more chronic injuries (>6 weeks), in which healing of the CC ligaments cannot be predicted, reconstruction of the AC joint and the CC ligament complex has become the recommended treatment option. In the literature, various techniques have been described with respect to the use of biological or nonbiological grafts or the transfer of local ligaments or tendons. In addition, a variety of augmentation devices to stabilize the AC joint while the reconstruction is healing have been reported, including spanning hook plates and cortical suspensory devices.²⁹ To date, there is a paucity of literature comparing the clinical results of the various different techniques for the surgical treatment of chronic AC joint instability. Therefore, the objective of this study was to systematically review and quantitatively compare the results of different surgical techniques for the treatment of chronic high-grade AC joint instability.

Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.²⁶ One independent reviewer systematically searched MEDLINE (via Ovid), PubMed (National Library of Medicine), Embase (Elsevier, Amsterdam, The Netherlands), and the Cochrane Library (John Wiley & Sons, Hoboken, NJ, USA), with the last search performed on April 25, 2018. The database search was limited to level I, II, III, and IV studies; English-language studies; and human studies. The search strategy applied a combination of MeSH (Medical Subject Headings) and keyword searches using the following search terms: "acromioclavicular joint instability" and "acromioclavicular joint reconstruction." The references of selected articles were also reviewed, when applicable, to identify additional studies.

Two independent reviewers (P.B. and J.C.) screened all articles eligible for inclusion. The inclusion criteria were as follows: chronic injuries, defined as those with a duration of more than 6 weeks after trauma; high-grade injuries (Rockwood grades III-VI); surgical treatment for which the technique was described; presentation of clinical (primary) and radiologic (secondary) outcome measures; minimum follow-up period of 12 months; and age of 18 years or older. The exclusion criteria included any history of fracture of the distal clavicle, acute AC joint injuries with an operation performed within the first 6 weeks after trauma, a follow-up period of less than 1 year, level V evidence, laboratory studies, radiographic studies, biomechanical studies, and meta-analyses.

Studies that met all the aforementioned criteria were reviewed, and the following data were extracted: study design, level of evidence, treatment method, number of patients, mean age, length of follow-up, complications, and clinical as well as radiologic outcome measures. Clinical outcomes were evaluated for studies with both preoperative and postoperative Constant scores¹⁰ available. The visual analog pain scale, Simple Shoulder Value, Oxford Shoulder Score,¹¹ Nottingham Shoulder Scale,⁸ University of California–Los Angeles score,¹⁴ and/or American Shoulder and Elbow Surgeons score³⁷ were assessed as well. Planned second operations for removal of temporary additional stabilization with metal hardware were not counted as complications.

Three different treatment groups were established and compared: nonbiological fixation between the coracoid and clavicle, such as suture loops and synthetic ligaments (group 1); biological reconstruction of the CC ligaments, such as allograft or autograft tendon reconstruction (group 2); and ligament and/or tendon transfer, such as the Weaver-Dunn or Dewar-type procedure (group 3). Furthermore, we aimed to perform a separate analysis with the exclusion of grade III injuries to evaluate only distinctly higher-grade injuries (Rockwood grades IV-VI).

Results

Study characteristics

Our search strategy generated 960 studies online and by citation tracking. Of these, 829 were excluded because of failure to meet the inclusion criteria by screening the title or were removed because they were duplicate articles. The abstracts of the remaining 131 citations were then reviewed, which resulted in an additional 67 exclusions. Review of the full-text articles of the remaining 64 studies resulted in further exclusion of 37 studies and final inclusion of 27 studies (Fig. 1). Five studies compared 2 of the 3 main techniques, and of those, 2 were level II and 3 were level III studies.^{12,15,20,21,32}

Group 1: nonbiological fixation between coracoid and clavicle (eg, suture loops and synthetic ligaments)

Eight studies with a total of 208 patients reported on AC joint reconstruction using a nonbiological fixation

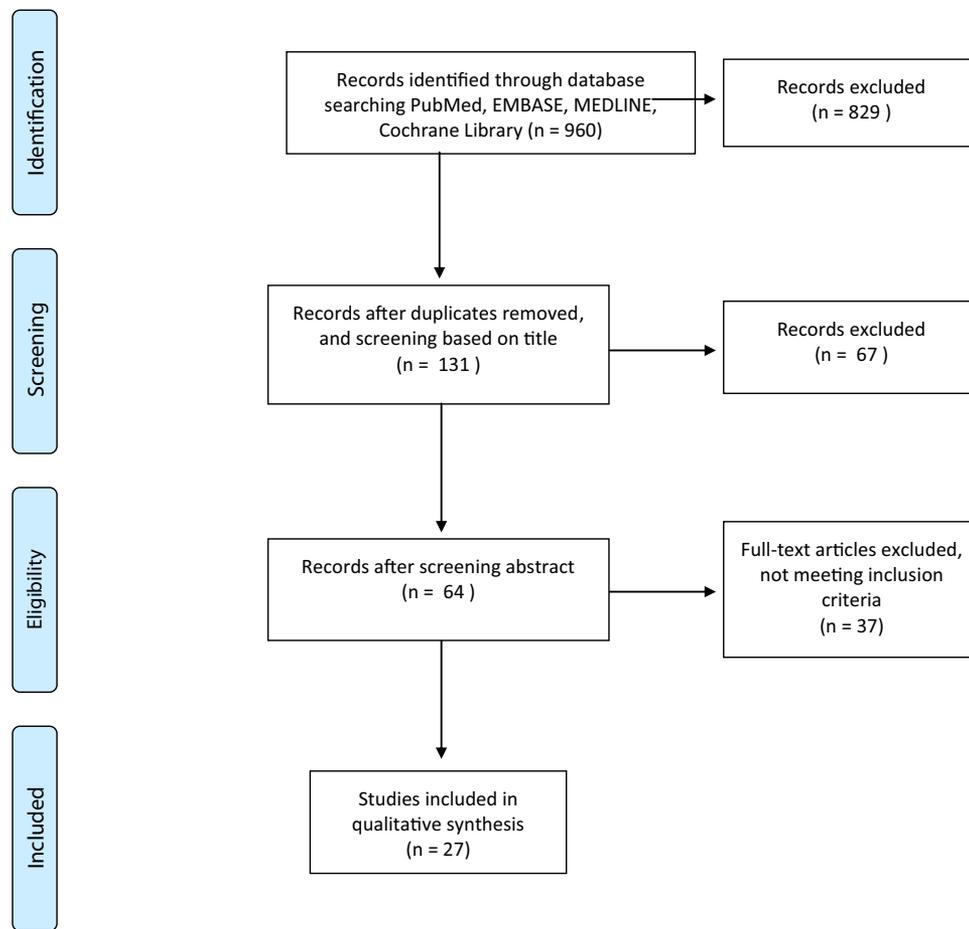


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flowchart showing application of selection criteria to studies identified with search strategy.

method.^{5,12,13,17,21,24,34,38} Of these studies, 1 had level II evidence, 3 had level III, and 4 had level IV. The average time from injury to surgery was 11 months (range, 3-21 months), and the mean follow-up period was 32 months (range, 15-55 months). Of the patients in group 1, 44.7% ($n = 93$) received the Ligament Advanced Reinforcement System (LARS; Surgical Implants and Devices, Arc-sur-Tille, France); 28.3% ($n = 59$) underwent AC joint reconstruction with a double polyester prosthetic ligament with Lockdown (Lockdown Medical, Redditch, UK), formerly known as Surgilig (Surgicraft, Redditch, UK); and 26.9% ($n = 56$) received a Dacron (polyethylene terephthalate) or Gore-Propaten (Gore, Newark, Delaware, USA) vascular graft.

In terms of functional outcomes, only 3 of the 8 studies ($n = 89$) reported mean preoperative and postoperative Constant scores (Table I). The mean preoperative score was 50.3 points (range, 44-55 points). At the time of follow-up, the mean postoperative Constant score improved to 87.2 points (range, 82-93 points). Of the 208 patients, 51 were reported to have higher-grade injuries (Rockwood grade IV, V, or VI). Study characteristics,

patient demographic data, patient-reported and radiographic outcomes, and complications are reported in [Supplementary Table S1](#) and [Table II](#).

Table I Overview of preoperative and postoperative Constant scores according to acromioclavicular joint reconstruction technique

	Mean preoperative Constant score (range)	Mean postoperative Constant score (range)	No. of studies and patients
Nonbiological (synthetic fixation)	50.3 (44.1-55)	87.2 (82-92.8)	3 studies and 89 patients
Biological (tendon graft)	62.9 (43.5-72.3)	92.4 (85.7-96)	5 studies and 86 patients
Ligament and/or tendon transfer	72 (70-75.1)	87.4 (82-91)	3 studies and 49 patients

Table II Surgical techniques in group 1 (nonbiological fixation)

Technique	No. of patients	%
LARS	93	44.7
Surgilig/Lockdown	59	28.3
Vascular graft	56	26.9
Total	208	

LARS, Ligament Advanced Reinforcement System.

Group 2: biological reconstruction of CC ligaments (eg, allograft or autograft ligament reconstruction)

Ten studies with a total of 142 patients reported on AC joint reconstruction using a free tendon graft.^{12,15,16,18,20,27,30,32,33,39} Of these studies, 3 had level II evidence, 2 had level III, and 5 had level IV. AC joint reconstruction was performed with a hamstring autograft in 66.2% of group 2 patients (n = 94), a tendon allograft in 21.1% (n = 30), and a palmaris longus tendon allograft in 12.7% (n = 18). Mean preoperative Constant scores were reported in 5 of the 10 studies (n = 86); these ranged from 44 to 72 points and reached 62.9 points on average (Table I). The mean postoperative Constant scores in these studies ranged from 86 to 96 points, with an average score of 92.4 points. Of the 142 patients, 71 (50%) had higher-grade Rockwood injuries (grade IV, V, or VI). Study characteristics, patient demographic data, patient-reported and radiographic outcomes, and complications are reported in Supplementary Table S2 and Table III.

Group 3: ligament and/or tendon transfer (eg, Weaver-Dunn or Dewar-type procedure)

Fourteen studies with a total of 243 patients reported on AC joint reconstruction using a ligament and/or tendon transfer.^{1,2,6,7,15,19-23,28,32,35,36} Of these studies, 1 had level II evidence, 5 had level III, and 8 had level IV. Of the 243 patients, 94 (39%) had higher-grade Rockwood injuries (grade IV, V, or VI). AC joint reconstruction was performed with a modified Weaver-Dunn technique in 83.8% (n = 201) and with a conjoint tendon transfer in 16.3% (n = 39). Only 3 of 14 studies (n = 49) reported mean preoperative

Table III Surgical techniques in group 2 (biological reconstruction)

Technique	No. of patients	%
Hamstring autograft	94	66.2
Palmaris longus	18	12.7
Allograft	30	21.1
Total	142	

Table IV Surgical techniques in group 3 (ligament and/or tendon transfer)

Technique	No. of patients	%
Modified Weaver-Dunn procedure	204	84
Conjoined tendon transfer	39	16
Total	243	

Constant scores, which ranged from 70 to 75 points and reached 72 points on average (Table I). The mean postoperative Constant scores in these studies ranged from 82 to 91 points, with an average score of 87.4 points. Three patients in this group had to undergo early revision owing to secondary loss of reduction and, therefore, could only be included in the complication analysis.

Study characteristics, patient demographic data, patient-reported and radiographic outcomes, and complications are reported in Supplementary Table S3 and Table IV.

Comparison between the 3 groups

Patients and study characteristics are summarized in Table V. Group 2 had the highest rate of previous AC joint stabilization, at 33.8% (n = 48), compared with 8.6% (n = 21) in group 3 and 5.3% (n = 11) in group 1. In group 3, 40% of patients (n = 98) underwent additional temporary stabilization with metal hardware (eg, hook plate, K-wires, cerclage wires, and Bosworth screws), which had to be removed as a planned second operation. Additional temporary stabilization was performed in 12.5% of patients in group 1 (n = 26) compared with 8.5% in group 2 (n = 12).

Complications

A detailed comparison of complications among the 3 treatment groups is shown in Table VI. The overall complication rates for all 3 groups were similar: 14.9% (n = 31) for nonbiological fixation (group 1), 15.5% (n = 22) for biological reconstruction (group 2), and 17.3% (n = 42) for ligament and/or tendon transfer (group 3). The overall complication rate was 16% (n = 95). The most common complication was secondary loss of reduction (overall, 6.7%; n = 40). On analysis of secondary loss of reduction ("failure") only, group 1 had a rate of 8.2% (n = 17), group 2 had a rate of 7% (n = 10), and group 3 had a rate of 5.3% (n = 13) on average. The mean infection rate was 1.9% (n = 4) in group 1, 4.2% (n = 6) in group 2, and 7.4% (n = 18) in group 3, with an overall infection rate of 4.7% (n = 28). Fractures were noted only in group 1, at a rate of 2.4% (n = 5), of which 3 were coracoid fractures and 2 were clavicle fractures. A separate analysis of higher-grade Rockwood injuries, that is, grades IV to VI, could not

Table V Overview of patient characteristics of 3 groups

Characteristic	Nonbiological (synthetic fixation)	Biological (tendon graft)	Ligament and/or tendon transfer
No. of studies included	8	10	14
No. of patients included	208	142	243
Mean age, yr	35	39	38
Mean follow-up, mo	32	31	35
Mean time from injury to surgery, mo	11	39	16
No. of patients with Rockwood grades IV-VI, n (%)	51 of 208 (24.5)	71 of 142 (50)	94 of 243 (38.7)
Previous AC joint reconstruction, n (%)	11 of 208 (5.3)	48 of 142 (33.8)	21 of 243 (8.6)
Temporary metal hardware, n (%)	26 of 208 (12.5)	12 of 142 (8.5)	98 of 243 (40)
Complications reported, n (%)	31 of 208 (14.9)	22 of 142 (15.5)	42 of 243 (17.3)

AC, acromioclavicular.

be performed sufficiently because of lack of separate data presentation in most related studies.

Discussion

The aim of this systematic review was to evaluate different techniques for reconstruction of chronic AC joint instability. However, among the 27 studies that met the inclusion criteria, the majority were level III and IV studies, with no level I studies identified. The paucity of higher-quality research, as well as the heterogeneity in study designs, makes interpretation more difficult and emphasizes the fact that further level I and II studies are essential to draw more significant conclusions.

In specific comparative clinical studies of the 3 different AC joint reconstruction methods, tendon or ligament transfers, such as the Weaver-Dunn procedure, showed worse clinical and radiographic results.^{12,15,20,21,32} In the literature, 2 level II studies have been performed, 1 comparing biological reconstruction using autologous semitendinosus tendon graft with the modified Weaver-Dunn procedure³² and the other comparing semitendinosus allograft reconstruction with LARS ligament reconstruction.¹² Tauber et al³² (2009) compared AC joint

stabilization with a free semitendinosus autograft in 12 patients vs. a modified Weaver-Dunn procedure in 12 patients. In their prospective study, the free tendon graft group showed significantly superior results both clinically and radiographically. In both groups, the AC joint reconstruction was secured with a cerclage wire, which had to be removed by a second operation. In the other study, which was a prospective comparative study, Fauci et al¹² (2013) compared allograft tendon vs. synthetic ligament reconstruction (LARS) in 40 patients. In their study, the allograft tendon group achieved significantly better clinical scores than the synthetic ligament group at both 1 and 4 years.

In a study by Kumar et al²¹ (2014), open AC joint reconstruction with a modified Weaver-Dunn technique was compared with Surgilig CC ligament reconstruction. Reconstruction with the polyester ligament resulted in significantly higher postoperative scores, as well as an earlier return to work and sports. In a retrospective cohort study with 32 patients, Kocaoglu et al²⁰ (2017) compared 2 open CC ligament reconstruction techniques: a modified Weaver-Dunn procedure vs. a palmaris longus autograft reconstruction technique using the GraftRope system (Arthrex, Naples, FL, USA). Both significantly better clinical outcomes and radiologic benefits were reported in the tendon graft group.

Table VI Summary of complications overall and according to mode of fixation

	Nonbiological (synthetic fixation), n (%)	Biological (tendon graft), n (%)	Ligament and/or tendon transfer, n (%)	Overall, n (%)
Overall complications	31 of 208 (14.9)	22 of 142 (15.5)	42 of 243 (17.3)	95 of 593 (16)
Failure and/or secondary loss of reduction	17 of 208 (8.2)	10 of 142 (7)	13 of 243 (5.3)	40 of 593 (6.7)
Infection	4 of 208 (1.9)	6 of 142 (4.2)	18 of 243 (7.4)	28 of 593 (4.7)
Pain and/or stiffness	3 of 208 (1.4)	1 of 142 (0.7)	6 of 243 (2.5)	10 of 593 (1.7)
Hematoma	0	0	1 of 243 (0.4)	1 of 593 (0.2)
Hypoesthesia at tendon harvest site	0	5 of 142 (3.5)	0	5 of 593 (0.8)
Metal-ware complication	2 of 208 (1)	0	4 of 243 (1.6)	6 of 593 (1)
Fracture	5 of 208 (2.4)	0	0	5 of 593 (0.8)

Fraschini et al¹³ published a retrospective comparative study with 3 different treatment groups and 30 patients per group: (1) conservative therapy, (2) an AC joint reconstruction technique with a Dacron prosthesis, and (3) LARS reconstruction. Both the Dacron and LARS groups had better clinical results; however, the Dacron group had a high complication rate (43%). In our study, about 27% of the patients included in group 1 were treated with a vascular graft, such as the Dacron prosthesis. This technique seems insufficient and could be a reason for the slightly higher complication rate in the group with synthetic ligament stabilization. However, in another study, Vitali et al³⁴ found that clinical and radiographic results after open AC joint stabilization with a Gore-Propaten vascular graft were deemed to be successful, with no complications reported.

The overall complication rates in our study were similar in all 3 groups, with the highest rate in the ligament and/or tendon transfer group, at 17.3%. On the other hand, this group had the lowest rate of secondary loss of reduction, at 5.3%. The most common complication in all groups was secondary loss of reduction. In the literature, as in our study, secondary loss of reduction is the most common complication after AC joint stabilization. Singh et al³⁰ reported a high failure rate in a retrospective case series of 9 patients, of whom 5 with chronic injuries could be included in the systematic review as they were treated with a palmaris longus autograft or tendon allograft and GraftRope stabilization. Failures were considered to have occurred in 3 of the 5 patients owing to secondary loss of reduction. As such, palmaris longus tendon graft reconstruction seems inferior compared with stronger and more robust tendons such as semitendinosus and gracilis grafts. However, despite the results and complications of palmaris longus tendon grafts, which accounted for approximately 13% of cases in this group, the clinical and radiographic results seemed to be sufficient and overall were not inferior to those in the other groups. Furthermore, only this group had the complication of postoperative hypoesthesia at the tendon harvest site, which was seen in 3.5% of patients, which added to the study's overall complication rate of 15.5%. On the other hand, fractures were only documented in group 1 after stabilization with a synthetic ligament, with 2.4% of patients in this group having had fractures, giving an overall complication rate of 14.9%. An interesting finding was that in all groups but group 3 with stabilization with the Weaver-Dunn procedure or conjoined tendon transfer, in which infection was the most common complication (7.4%), secondary loss of reduction was the most frequently seen complication. This higher infection rate could possibly be a result of the more frequent use (40%) of additional temporary stabilization with hardware. Moatshe et al²⁵ (2018) reported a complication rate of

26.3% in patients treated with a hook plate or K-wires in a systematic review of both acute and chronic stabilizations.

From our systematic review, we found that, despite there being 3 main types of reconstruction methods, there were still wide variations in technique within these groups, making accurate interpretation difficult. One example of this was seen in the ligament and/or tendon transfer group, in which some studies used additional temporary stabilization such as a hook plate or K-wires. These patients all underwent planned secondary operations, which were recorded as reoperations but not classified as complications.

Conclusion

On comparison of the results of 3 different AC joint reconstruction methods for chronic dislocations, all techniques showed similar complication rates. In the only available level II studies, AC joint reconstruction with a tendon graft showed superior results. However, level I or II studies are required to validate this conclusion. The current literature pertaining to the outcomes of surgical treatment of chronic AC joint dislocation is largely composed of retrospective case series (level IV evidence), with few comparative studies (level II or III evidence) assessing the outcomes of different techniques. Given the lack of level I and II evidence on this subject, well-performed and sufficiently powered randomized controlled studies are needed to compare the various techniques to determine the most appropriate method of treating chronic AC joint instability.

Disclaimer

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Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jse.2019.03.005>.

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