

Modified Weaver-Dunn Procedure for Type 3 Acromioclavicular Joint Dislocation

Functional and Radiological Outcomes

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Background: Controversy surrounds the indication for treatment of type 3 acromioclavicular joint dislocation, and the optimal reconstructive technique has not yet been defined. Since the first description of the Weaver-Dunn procedure, several studies have described the clinical and radiological results that can be expected postoperatively; however, few studies have evaluated the outcomes of this technique for chronic type 3 acromioclavicular joint dislocation.

Purpose/Hypothesis: The purpose of this study was to evaluate the functional and radiographic mid- to long-term outcomes of a modified Weaver-Dunn procedure for chronic Rockwood type 3 acromioclavicular joint dislocation. We hypothesized that (1) functional outcomes comparable with sex- and age-matched healthy individuals could be achieved with the modified Weaver-Dunn procedure and (2) joint stability could be restored after surgery.

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

Methods: Out of 30 patients who sustained a chronic type 3 acromioclavicular joint dislocation, 27 had a minimum 12-month follow-up and were included in the study. All patients underwent a modified Weaver-Dunn procedure. The Constant-Murley score was used to assess patient postoperative function. Subjective evaluation of patient satisfaction with surgery was also recorded. Radiological assessment was performed postoperatively to evaluate superoinferior and anteroposterior joint stability.

Results: After a mean follow-up period of 51.6 months, the mean Constant-Murley score was 90.1, which was 97.2% that of a group of sex- and age-matched healthy individuals. In the multivariate analysis, higher Constant-Murley score was associated with male sex ($\beta = 0.385$; $P = .043$) and higher subjective satisfaction scale ($\beta = 0.528$; $P = .003$). All patients returned to their previous work and sport activity levels having high satisfaction with surgery. Successful vertical acromioclavicular joint reduction was obtained in all but 1 patient; however, horizontal joint stability was not completely restored with the modified Weaver-Dunn procedure. No intraoperative complications occurred, and the postoperative complication rate was 7.4%.

Conclusion: In patients with chronic type 3 acromioclavicular joint dislocation, the modified Weaver-Dunn procedure is an effective technique to restore vertical but not horizontal joint stability 4 years after surgery. High levels of satisfaction with surgery and functional outcomes comparable with sex- and age-matched healthy individuals can be achieved.

Keywords: chronic acromioclavicular joint dislocation; Rockwood type 3 dislocation; Weaver-Dunn; Constant-Murley score; outcome predictors; radiological assessment of acromioclavicular joint stability

Approximately 9% to 12% of all shoulder girdle injuries involve damage to the acromioclavicular (AC) joint²⁷; most of these injuries occur in the active population, typically in males in their second or third decade of life,²⁴ and can be caused by road accidents or during sport activities that

involve contact.¹¹ The treatment of AC joint injuries is based on the grade of injury and chronicity.

Classification of AC dislocation into 6 degrees of severity, as described by Rockwood et al,³⁰ is still one of the most commonly used classification methods. These injuries are graded according to the measured distance between the cranial rim of the coracoid and the caudal border of the clavicle. Type 3 injuries consist of complete rupture of both the AC and coracoclavicular (CC) ligaments with a superior displacement of the lateral end of the clavicle

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(radiographically, the CC distance in such cases is 25%–100% greater than in the normal shoulder).³⁵

Although consensus is available regarding nonsurgical treatment for low-grade dislocations (types 1 and 2) and surgical treatment for high-grade dislocations (types 4 to 6), controversy surrounds the indication for nonsurgical versus surgical treatment in patients with acute type 3 dislocation, with a trend toward initial nonoperative treatment in most cases.²⁷ In patients sustaining a type 3 AC joint dislocation with persistent pain and abnormal scapular motion after the initial 3 to 6 weeks of nonsurgical therapy, operative management has been recommended.⁴

To date, more than 150 variations of surgical treatment to manage symptomatic AC joint dislocations have been described,³ and more than 60 different techniques to reconstruct the CC ligaments after chronic injury have been described; however, the optimal reconstructive technique has not yet been defined.¹⁷ Weinstein et al³⁴ described the time point distinguishing acute versus chronic injury as 3 weeks after the date of AC dislocation because the AC and CC ligaments lose their potential to heal from 3 weeks after the AC joint injury. Other authors^{2,36} have defined a chronic injury after the fourth or the sixth week of AC dislocation.

Originally described by James Weaver and Harold Dunn in 1972,³³ the Weaver-Dunn procedure (WD) involves transfer of the coracoacromial (CA) ligament from the acromion to the lateral end of the clavicle. In their original series, Weaver and Dunn reported a failure rate of 28%. Therefore, Shoji et al³¹ proposed harvesting of the CA ligament together with acromial bone block to reinforce the repair. Further technical modifications by additional stabilizers have been proposed,^{1,8,9} with the purpose of reducing the risk of postoperative loss of reduction. The aim of this study was to evaluate the functional and radiographic mid- to long-term outcomes of a modified WD procedure for chronic type 3 AC joint dislocation. We hypothesized that (1) functional outcomes comparable with sex- and age-matched healthy individuals could be achieved with the modified WD procedure and (2) joint stability could be restored after surgery.

METHODS

A retrospective study with prospective data collection was undertaken on 54 patients whose medical care included a modified WD technique for AC joint dislocation between October 2003 and September 2016. The study protocol was approved by the local ethics committee.

Inclusion criteria were (1) type 3 AC joint dislocation at least 4 weeks after injury, (2) an unsuccessful immobilization of the affected limb through use of acromioclavicular sling (Acromion; RO+TEN srl), and (3) a minimum 12 months of clinical and radiological follow-up. Exclusion criteria were (1) prior shoulder surgery, (2) fracture or (3) dislocation of the shoulder, (4) rotator cuff tear, (5) lesion of the long head of the biceps, (6) neurological disorders of the upper extremities, and (7) any pathological condition in the contralateral shoulder. The diagnosis was based on clinical (injury history, signs and symptoms) and radiological evaluation of the shoulder (true anteroposterior [AP] and axillary lateral views). A magnetic resonance imaging scan was carried out to evaluate any additional intra- and/or extra-articular glenohumeral joint abnormality. The classification of AC joint dislocation was confirmed intraoperatively.

A total of 30 patients met the study criteria. Informed consent was obtained from all individual participants included in the study. In the current study, an injury was considered chronic after the fourth week from the date of dislocation. A patient was considered to have early surgery if the operation occurred between 4 and 6 weeks after injury; after this period, surgery was defined as delayed. Preoperatively, all patients had shoulder pain and weakness that interfered with their activities of daily living. Patients' symptoms included pain over the AC joint, a feeling of AC joint instability with popping or grinding of the joint, shoulder fatigue, and deformity of the shoulder.

Surgical Technique

The modified WD procedure was performed by the same surgeon (R.C.) (Figure 1).

The patient was placed in a beach-chair position and put under general anesthesia; the outer portion of the clavicle was exposed through a curved incision extending medially from the acromion along the lower border of the clavicle and curving over the coracoid. The origin of the anterior deltoid muscle was detached from the acromion and reflected laterally, facilitating exposure of the coracoid process and CA ligament. The CA ligament was detached from its acromial attachment together with a small piece of bone from the acromion to allow bone-to-bone healing. Two No. 2 nonabsorbable braided sutures (Orthocord; DePuy Mitek) were passed in a horizontal mattress fashion through the proximal portion of the ligament. A curved suture passer was used to direct surgical tape (FiberTape; Arthrex) around the base of the coracoid process. A 1-cm lateral clavicle resection was performed through use of an oscillating saw. The lateral end of the clavicle was prepared for

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Ethical approval for this study was obtained from Villa Maria Cecilia Hospital (ID: 03-2016).

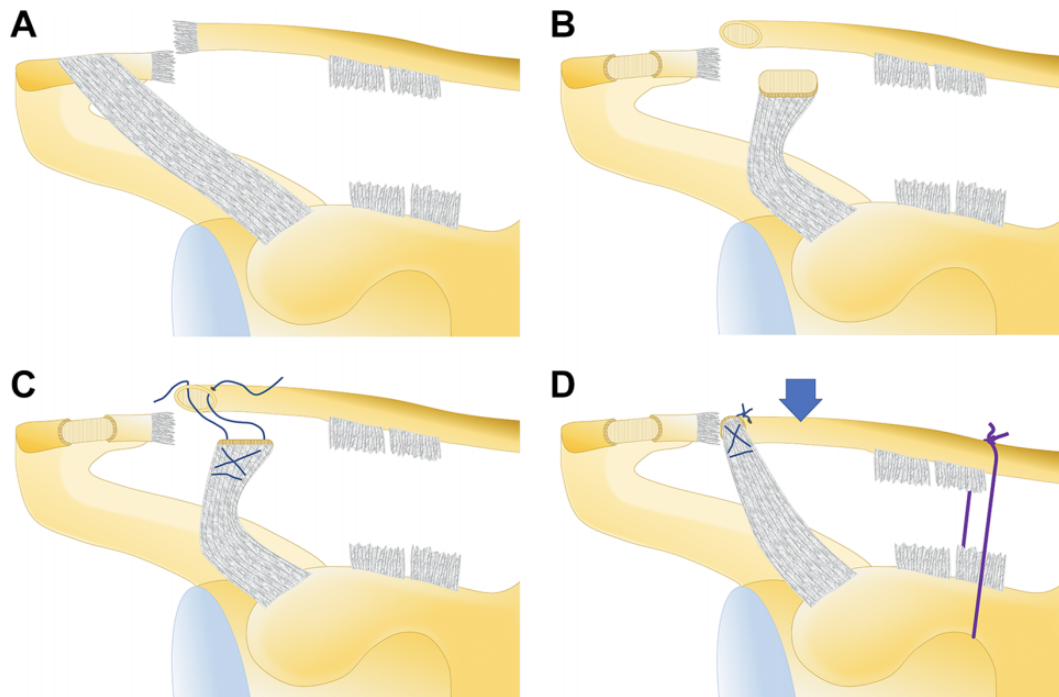


Figure 1. Schematic drawing of (A) a grade 3 acromioclavicular joint dislocation treated with a modified Weaver-Dunn procedure. (B) The lateral end of the clavicle is resected and the coracoacromial ligament is harvested with a tricortical bone block from the acromion. (C) The coracoacromial ligament, together with the acromial bone block, is prepared with 2 nonabsorbable braided sutures passed through drill holes performed at the lateral end of the clavicle. The clavicle is reduced, and a surgical tape is passed around the clavicle and coracoid process. (D) Thereafter, the acromial bone block together with the coracoacromial ligament is secured to the clavicle.

coracoacromial ligament transfer: 3 small drill holes were placed through the superior cortex of the lateral clavicle with a 2-mm drill bit. The sutures that were previously placed in the coracoacromial ligament were passed through the drill holes in the lateral clavicle; 1 of the 2 strands of each suture was passed through the center drill hole, whereas the other strand was passed through the anterior or posterior hole, and the 2 horizontal mattress sutures were tied. The clavicle was then held in a reduced position, and the surgical tape was tied over it to maintain this reduction. The anterior deltoid muscle was successively reattached.

Postoperatively, the arm was immobilized for 4 weeks in an acromioclavicular sling. Passive range of motion (ROM) exercises were initiated after this time. Active and active-assisted ROM was begun 6 weeks postoperatively; strengthening exercises were delayed until 8 weeks postoperatively.

Postoperative Functional Assessment

At follow-up, each patient was clinically evaluated by use of a 4-point subjective satisfaction scale¹⁵ (SSS) (4 = excellent, 3 = good, 2 = fair, 1 = poor) and the Constant-Murley score (CMS).¹² The strength domain of the CMS was tested by use of a dynamometer (Myometer 500 N; Atlantech Medical Devices) with the humerus on the scapular plane at 90° of abduction for maximal mechanical advantage. The

postoperative CMS score was normalized for sex and age using the following formula²⁰: $normalized\ CMS = (raw\ CMS / normal\ CMS) \times 100$. All patients were evaluated for intra- or postoperative complications and for their return to work and sporting activities.

Postoperative Radiological Evaluation

Patients underwent radiological examination with an AP view of both clavicles as described by Zanca³⁷ and an axillary lateral view as described by Bernageau and Patte.⁵ Radiographic measurements were expressed as ratios to overcome variations related to the patient's distance from the source, as previously described.¹⁶ All measurements were performed in duplicate by 2 trained authors who were unaware of the patients' clinical characteristics (L.T. and M.M.). A consensus decision on the scores was reached in a final common readout.

In the Zanca view, the CC distance between the cranial rim of the coracoid and the caudal border of the clavicle was measured on both sides (Figure 2), and the ratio of injured to healthy CC distances was calculated. A CC ratio of 1 was considered indicative of anatomic reduction on the frontal plane.

In the Zanca view, the D/A ratio was calculated on the injured shoulder. A reference line was drawn through the inferior margin of the acromion. "A" was the height



Figure 2. Measurement of coracoclavicular (CC) ratio on Zanca view. The CC ratio is the coracoclavicular distance between the cranial rim of the coracoid and the caudal border of the clavicle.



Figure 3. Measurement of D/A ratio on Zanca view: “A” is the height of the acromion, between its inferior and superior margins. “D” is the distance between the line drawn through the inferior margin of the acromion and a parallel line passing through the lowest and most lateral point of the clavicle.

of the acromion, between its inferior and superior margins. “D” was the distance between the line through the inferior margin of the acromion and a parallel line passing through the lowest and most lateral point on the clavicle (Figure 3). In type 3 injuries, the displacement of the lateral end of the clavicle is equal to the acromion’s thickness, and the D/A ratio is ≥ 1 . A D/A ratio equal to 0 was considered to be indicative of an anatomic reduction on the frontal plane.

In the Zanca view, the transferred CA ligament ossification was evaluated as proposed by Calvo et al.¹⁰

In the axillary view, the X/Y ratio of the clavicle’s horizontal displacement relative to the acromion was calculated. The first reference line was drawn through the middle of the outer quarter of the clavicle along the longitudinal axis. Next, a parallel line was drawn through the most anterior and lateral margins of the clavicle. The

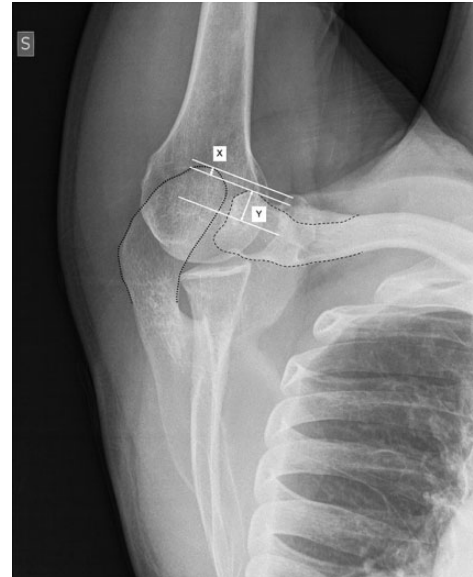


Figure 4. Measurement of X/Y ratio on axillary view: “Y” is the distance between a line drawn through the middle of the outer quarter of the clavicle along the longitudinal axis and a parallel line drawn through the most anterior and lateral margin of the clavicle. “X” is the distance between a third line, parallel to the other 2, drawn through the most anterior margin of the acromion and the one passing through the most anterior and lateral margin of the clavicle.

distance between these lines was defined as “Y.” A third line, parallel to the other 2 lines, was drawn through the most anterior margin of the acromion; this line was used to calculate the distance “X” between the anterior edge of the acromion and the anterior edge of the clavicle (Figure 4). An “X” value and, thus, an X/Y ratio equal to 0 was considered to be indicative of an anatomic reduction on the horizontal plane. Preoperatively, the mean X/Y ratio was 1.6 ± 1.1 (range, 0.5-3).

Statistical Analysis

All data were collected, measured, and reported within 1-decimal place accuracy. Uni- and multivariate linear regressions were performed on the whole population to test possible outcome predictors. The explanatory and confounding pre- and postoperative variables included in the analysis were sex (categorical), age (continuous), surgery site (categorical), dominant limb (categorical), early/delayed surgery (categorical), follow-up (continuous), CC ratio (continuous), D/A ratio (continuous), and X/Y ratio (continuous). SSS (continuous) and CMS (continuous) were treated as outcomes of the preoperative and postoperative variables. Only explanatory and confounding variables that showed a trend toward an association (eg, $P < .10$) with the outcome of interest in the univariate analysis were inserted in the multiple regression analysis. A P value of less than .05 was considered significant. IBM SPSS Statistics

TABLE 1
Clinical Outcomes of Study Population^a

Outcome Score	Value
SSS	4 ± 0.2 (3-4)
CMS pain	14.3 ± 2 (6-15)
CMS ADL	17 ± 4.5 (10-20)
CMS ROM	39.9 ± 0.8 (36-40)
CMS strength	19.1 ± 5.6 (4-25)
CMS total	90.1 ± 8.4 (64.5-100)
CMS normalized (%)	97.2 ± 8.1 (70-109)

^aValues are reported as mean ± SD (range). ADL, activities of daily living; CMS, Constant-Murley score; ROM, range of motion; SSS, subjective satisfaction scale.

software (version 21.0.0.1; IBM Corp) was used for database construction and statistical analysis.

RESULTS

Of the initial 30 patients, 3 were lost at follow-up, leaving 27 patients available for the final evaluation. There were 24 men and 3 women, with a mean ± SD age of 50.5 ± 14.6 years (range, 21.8-74 years) at surgery. The dominant hand was involved in 55.5% of cases. Of these patients, 13 (48%) performed sport activity: including cycling (n = 8), rugby (n = 3), and skiing (n = 2).

The mean time from injury to surgery was 4.5 ± 4 months (range, 1-14 months), and 37% and 63% of patients received early and delayed surgery, respectively. The mean surgery time was 51.7 ± 2.7 minutes (range, 47-58 minutes).

Clinical outcomes after a mean follow-up of 51.6 ± 38.1 months (range, 13.2-137.3 months) are shown in Table 1. At the final follow-up visit, the mean patient CMS was 97.2% that of the sex- and age-matched healthy individuals, and 81.5% of patients showed a CMS equal to or higher than the normative data. All patients returned to their previous level of work and sporting activity.

Postoperatively, the CC ratio was 1.4 ± 0.5 (range, 0.7-2.9), the D/A ratio was 0.4 ± 0.3 (range, 0-0.8) and the X/Y ratio was 1.3 ± 0.5 (range, 0.2-2.9). Cohen kappa coefficients for intraobserver and interobserver reliability of the CC ratio were 0.9 and 0.83, respectively; for the D/A ratio were 0.85 and 0.81, respectively; for the X/Y ratio were 0.83 and 0.77, respectively (coefficients >0.8, excellent; >0.6, good).

As shown in Table 2, the CMS was directly related to male sex ($P = .016$) and a higher SSS ($P = .002$). No radiological parameters were associated with CMS. In the multivariate analysis, higher CMS was associated with male sex ($\beta = 0.385$; $P = .043$) and higher SSS ($\beta = 0.528$; $P = .003$). This model accounted for 53.1% of the postoperative variance of the CMS.

No intraoperative complications occurred. The postoperative complication rate was 7.4%: 1 peri-incisional dysesthesia and 1 loss of reduction were noted. The patient who showed a loss of reduction had a 2.9 CC ratio, a 0.8 D/A ratio, and a 1.2 X/Y ratio; however, a CMS of 100 was recorded 34 months after surgery. Mild, moderate, and

TABLE 2
Univariate Analysis: Factors Predicting Postoperative Constant-Murley Score^a

	<i>P</i>	β
Male sex	.016	0.459
Age	.718	-0.074
Surgery on dominant limb	.229	-0.239
Early surgery	.052	-0.378
CC ratio	.316	0.201
D/A ratio	.066	0.359
X/Y ratio	.69	0.08
Follow-up	.33	-0.195
Subjective satisfaction scale	.002	0.57

^aCC, coracoclavicular. See Figure 2 for an explanation of the CC ratio, Figure 3 for an explanation of the D/A ratio, and Figure 4 for an explanation of the X/Y ratio.

severe ossifications of the CC ligaments were observed in 3 patients (11.1%), 4 patients (14.8%), and 1 patient (3.7%), respectively.

DISCUSSION

In the current study, after a mean 4-year follow-up, the overall clinical outcomes of the modified WD procedure were successful, with high patient satisfaction and functional scores that were similar to those of sex- and age-matched healthy individuals. A reduction of AC dislocation in the frontal plane was noted in all but 1 patient, there were no major complications such as coracoid or clavicular fractures related to the index procedure, no revision procedures were performed, and all patients returned to their previous level of work and sporting activity.

To our knowledge, the study population in the present article represents the largest series, similar to that of the work by Bezer et al,⁶ of chronic type 3 AC joint dislocation treated with the modified WD procedure. Since the first description of the WD procedure, several studies have described the clinical and radiological results that can be expected postoperatively; however, the heterogeneity of the WD literature concerning the different population characteristics, grade and chronicity of injury, surgical techniques, number and type of concomitant procedures, and postoperative radiological measurements makes it challenging to compare the outcomes reported in the different studies. To the best of our knowledge, only 4 studies^{1,6,22,25} have evaluated the outcomes of the modified WD procedure for chronic type 3 AC joint dislocation (Table 3).

Limitations affecting these 4 studies include small sample size,^{1,22} inconsistency of the surgical technique used to treat the patients,²⁵ lack of standardized postoperative radiological evaluation,^{1,22} and unclear criteria for postoperative reduction.^{1,22}

In the current study, patients showed a mean postoperative CMS of 90.1, and their CMS values were 97.2% those of the sex- and age-matched healthy individuals. Kumar

TABLE 3
Studies Reporting Clinical and Radiological Outcomes After Modified Weaver-Dunn Procedure for Chronic Type 3 Acromioclavicular Joint Dislocation^a

Lead Author (Year)	No. of Patients	Patient Age, y	Technique	Postoperative Functional Evaluation	Postoperative Radiological Evaluation		Follow-up, mo
					Views	Criteria of Reduction	
López-Alameda ²⁵ (2018)	28	34.7 ± 9.7	WD with various methods of reinforcement, not clearly specified	DASH: 12.9 ± 16.8 OSS: 42.7 ± 7.8	AP of clavicle	Calvo et al. ¹⁰ criteria: complete reduction (94.4%), partial reduction (5.6%)	73 ± 32.1
Al-Ahaideb ¹ (2014)	9	38.6 ± 6.8 ^b	WD with TightRope (Arthrex)	CMS: 97 ± 3.8 ^b	Not clearly specified	Not clearly specified: 7 patients had anatomic repositioning; 2 patients had slight loss of reduction	20 ± 6.5 ^b
Bezer ⁶ (2009)	29	29.9 ± 8.3	WD with 2 Ethibond (Ethicon)	CMS: 89.9 ± 10.8	Bilateral nonstressed and stressed AP of AC joint and CT with 3D reconstruction	AC subluxated if CC distance increased ≥3 mm in stress view: reduced (89.7%), subluxated (10.3%)	69.5 ± 35.4
Kumar ²² (2007)	15	42 ± 8.5 ^b	WD with polyester tape (Marsilene)	CMS: 91 ± 7.5	Radiographs were not routinely done except for patients with persistent symptoms		26 ± 13 ^b

^aPatient age, scores, and duration of follow-up are expressed as mean ± SD. 3D, 3-dimensional; AC, acromioclavicular; AP, anteroposterior; CC, coracoclavicular; CMS, Constant-Murley score; CT, computed tomography; DASH, Disabilities of the Arm, Shoulder and Hand; OSS, Oxford Shoulder Score; WD, Weaver-Dunn.

^bCalculated from the range: (maximum range – minimum range)/4.

et al²² and Bezer et al⁶ reported similar postoperative CMS values in their series, and Al-Ahaideb¹ reported a postoperative CMS score of 97% compared with the uninjured side after a 20-month follow-up. We found that females showed a statistically significant correlation with poorer CMS. However, the greater likelihood of lower functional outcomes in women should be interpreted with caution because of the small sample size. As also reported by Hegazy et al,¹⁹ we failed to find significant correlations between the clinical scores and any of the radiological parameters.

For the vertical postoperative AC joint reduction, the modified WD procedure was confirmed to satisfactorily address the superoinferior instability in the current series. We reported mean D/A and CC ratios of 0.4 and 1.4, respectively. A postoperative D/A ratio less than 1 is indicative of a reduction of type 3 dislocation in the frontal plane according to the Rockwood classification.¹⁶ The same mean CC ratio was reported by Hegazy et al¹⁹ in chronic type 3 AC joint dislocations after the modified WD procedure. We next showed that the modified WD procedure is unable to successfully control the horizontal AC displacement. Indeed, the X/Y ratio that was used to assess the anteroposterior reduction of the AC joint confirmed a nonanatomic reduction in the axial plane (mean X/Y ratio = 1.3).

To address both vertical and horizontal instability, further surgical techniques using tendon or synthetic grafts have been proposed. It has been suggested that the reconstruction of both CC ligaments ensures better control of translation on the axial plane compared with procedures involving the reconstruction of only 1 CC ligament.¹⁸ To the

best of our knowledge, only 1 study has compared functional and radiological outcomes of modified WD for chronic grade 3 AC joint dislocation with reconstruction of both CC ligaments,¹⁹ and the authors reported better Oxford shoulder and Nottingham clavicle scores after AC joint reconstruction using the semitendinosus tendon graft. However, the small sample size of the study (10 patients per group) does not permit definitive conclusions. Tauber et al³² compared the results of a modified WD and anatomic reconstruction of CC ligaments with semitendinosus transfer in patients with grade 3 to 5 AC joint dislocation and found a higher postoperative CMS after anatomic reconstruction. Notably, the postoperative CMS values reported by Tauber et al for the WD group are much lower than the values reported in the current study or by other authors.^{1,6,21,29} Kocaoglu et al²¹ reported small yet statistically significant postoperative CMS differences between patients treated with a palmaris longus tendon graft through the GraftRope system (Arthrex) and a modified WD procedure. The authors reported differences of 3.2 and 4.8 points between the 2 surgical techniques on the CMS and the American Shoulder and Elbow Surgeons (ASES) Standardized Shoulder Form, respectively. To the best of our knowledge, data are lacking on minimal clinically important difference (MCID) values for the outcome instruments used to evaluate patients with AC joint dislocation; however, the results reported by Kocaoglu et al are lower than the MCID values reported for CMS and ASES scores to study rotator cuff tears.¹³ In this light, no firm conclusions can be drawn by these studies^{23,25,26} in comparing the postoperative functional outcomes of modified WD versus other techniques. Potential drawbacks for the use of

autograft include the need for large holes to be drilled in the clavicle and the coracoid, increased risk of fracture, graft site morbidity, vitality of the tissue, and cost.⁸

Reconstruction of chronic AC joint dislocation using a synthetic ligament achieved better functional and radiological scores and earlier return to work and sports compared with the modified WD procedure²³, however, inflammation, rejection, and graft shredding have been described with the use of synthetic ligaments.¹⁴ In addition, both tendons and synthetic grafts are associated with the use of suspension devices that represent expensive components of the surgical procedure.

Transfer of the CA ligament may be associated with the risk of ongoing pain, instability, and recurrent subluxation because of stretching or failure of fixation of the reattached CA ligament.³³ The 7.4% complication rate of the current study is lower than the rate reported after the modified WD procedure (12.8%) and the rate after a free ligament transfer procedure (10.3%) in a recent systematic review.²⁸ Even though a 5.4% reoperation rate²⁸ has been reported after a modified WD procedure, in the current study, only 1 patient had loss of reduction, and the patient refused revision surgery because of satisfactory functional outcomes.

Boileau et al⁷ described an all-arthroscopic, modified WD procedure with double-button (EndoButton; Smith & Nephew Endoscopy) fixation for chronic type 3 to 5 AC joint dislocation and found a mean postoperative CMS of 85.5 and an overall redislocation rate of 11% after a mean follow-up of 36 months. Anatomic CC ligament arthroscopically assisted reconstruction has also been proposed. Loriaut et al²⁶ described the use of a double-button TightRope (Arthrex) for the treatment of type 3 and 4 AC dislocation and reported a mean postoperative CMS of 94.7 and an overall redislocation rate of 7.7%. The current study showed similar postoperative scores and a lower rate of recurrence. However, arthroscopically assisted AC reconstruction has possible advantages in its minimally invasive nature, direct visualization of the reduction and placement of coracoid fixation, and the possibility of addressing additional abnormalities.

We found ossification of the CC ligaments in 29.6% of patients. A recent study²⁵ showed a similar ossification rate of 33.3% after a modified WD procedure, confirming a tendency for calcium to deposit along the course of the transferred ligament.

The major limitations of the current study are its retrospective nature, the lack of a control group, and the absence of a preoperative CMS score. However, the homogeneous characteristics of the sample population affected by chronic type 3 AC joint dislocation, the use of validated and standardized radiological assessment, and a sample size comparable with the largest series available⁶ represent strengths of the study.

In summary, the modified WD procedure is an effective technique to restore vertical but not horizontal joint stability in patients with chronic type 3 AC joint dislocation 4 years after surgery. High levels of satisfaction with surgery and functional outcomes comparable with sex- and age-matched healthy individuals can be achieved despite nonanatomic horizontal joint reduction.

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