

Anatomic Reduction is not essential for Good Functional Outcome in Surgical Treatment of Acromioclavicular Dislocation (Quality of the Reduction in Ac Dislocation)

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Abstract

Background: Treatment of displaced acromioclavicular disjunction is not consensual. The goal is to evaluate the concordance between clinical and radiological results in acute displaced acromioclavicular joint dislocation (ACD) at a minimum 1 year's follow-up.

Methods: Fourteen patients underwent open coracoclavicular and acromioclavicular ligament reconstruction by artificial ligament (Acrolig™, Fx Solutions) and twelve underwent arthroscopic coracoclavicular ligament reconstruction by a single paired endobutton (Zip Tight™, Zimmer Biomet). Shoulder function was assessed by an independent examiner with objective and subjective international validated scores. Frontal acromioclavicular displacement was measured all along the follow-up, and reduction quality at last follow-up was assessed frontally and laterally, and globally according to 5 groups of reduction, by 2 examiners.

Results: Rockwood classification distribution was: grade 3 (61.6%), grade 4 (30.8%) and grade 5 (15.4%). Mean follow-up was 26.6±8.2 months. All objective and subjective scores were "good" or "very good" at last follow-up (Constant-Murley = 94.1±4.8). Radiologic analysis according to reduction quality showed that anatomic reduction was twice as frequent in the frontal plane (23.1%) as in the sagittal plane (11.5%). Analysis of global reduction quality found 42% anatomic or good reduction, and 58% partial or poor reduction. There were no significant differences in any clinical scores according to reduction quality (on the different views). Comparison between groups "anatomic and good reduction" and "moderate and poor reduction" found no significant differences on any clinical scores neither.

Conclusion: Anatomic reduction would not seem to be mandatory for good functional results in displaced acute ACD.

Introduction

Acromioclavicular dislocation (ACD) is a frequent pathology with potentially severe functional and socioeconomic impact, as it mainly affects young and active patients [1-3].

Treatment is guided by the degree of displacement on X-ray, using the Rockwood classification [4]. Functional non-operative treatment is recommended for grades 1 and 2, while surgery is more often proposed beyond grade 3, although long-term superiority is unsure [5]. Management of grade 3 itself is the most controversial [6]. This lack of overall consensus is due to the fact that the Rockwood classification, despite recent modifications, shows only poor-to-moderate reproducibility, limiting its usefulness in guiding

treatment, and also that a hundred or so surgical techniques have been described, often in studies with low levels of evidence [7, 8]. These very different open or arthroscopic techniques can be classified as "anatomic", reconstructing the coracoclavicular and/or acromioclavicular ligament, by screws, artificial ligament or tendon graft, or "non-anatomic", such as the Weaver-Dunn technique or hook plates. Whatever the technique, results are mostly good, although with reduction loss in about 20% of cases [9].

The main study objective was to assess concordance between clinical and radiological results in acute displaced ACD at a minimum 1 year's follow-up. The study hypothesis was that clinical results correlate directly with radiologic reduction quality.

Materials and Methods

Patients

A single-center retrospective continuous series of acute Rockwood grade 3, 4 or 5 ACD was analyzed over the period November 2013 to February 2016.

Exclusion criteria comprised: age <18 years or >45 years, trauma-to-surgery time >45 days, and clinical and radiological follow-up <1 year.

Twenty-eight patients were included, and 6 excluded (for chronic ACD). Two patients were lost to follow-up (7.1%), leaving 26 patients (92.9%) for analysis.

The study protocol received approval from the inter-regional ethic committee of the author's affiliated institution; and patients were informed that the study was being conducted.

Methods

Procedures were performed by 2 senior surgeons, under general and locoregional anesthesia, using 2 techniques at the surgeon's discretion.

Fourteen patients underwent open coracoclavicular and acromioclavicular ligament reconstruction by artificial ligament (Acrolig™, Fx Solutions, and France). Twelve underwent arthroscopic coracoclavicular ligament reconstruction by a single paired endobutton (Zip Tight™, Zimmer Biomet, USA).

Postoperative course was identical for the 2 techniques. Patients were immobilized in an elbow-to-body brace for 6 weeks. Passive physiotherapy was initiated as of the first postoperative days, with active rehabilitation and muscle reinforcement as of day 45 and resumption of non-traumatic sport as of day 90.

Assessment Methods

At last follow-up, shoulder function was assessed by an independent examiner on Constant-Murley score, modified University of California - Los Angeles for acromioclavicular joint score (UCLA'ac'), Subjective Shoulder Value, Quick-Dash and rate of and time to return to sport at initial level [10-13].

Radiographic analysis was performed by 2 examiners on AP and lateral views. Preoperative Rockwood grade was determined. Percentage frontal acromioclavicular displacement was measured preoperatively, immediately postoperatively and at days 45 and 90 and at last follow-up (minimum 1 year). Reduction quality at last follow-up was assessed frontally and laterally, and globally (i.e., poorest frontal or lateral reduction score) according to 5 groups:

- Group 1: anatomic reduction;
- Group 2: good reduction (> 80% acromioclavicular surface contact);
- Group 3: partial reduction (60-80% acromioclavicular surface contact);
- Group 4: poor reduction (< 60% acromioclavicular surface contact);
- Group 5: no reduction (identical to preoperative aspect).

In case of discordance between examiners, joint analysis was repeated to reach consensus.

The main endpoint was the relation between radiographic reduction quality at last follow-up and clinical scores. The secondary endpoints were clinical and radiographic results according to surgical technique.

Statistical Analysis

Statistical analysis used Stata V12 software. All tests were 2-tailed, with the significance threshold set at $p < 5\%$.

Data were reported as numbers and percentages for qualitative variables, and as mean, standard deviation, median and interquartile range for quantitative variables.

Inter-group comparison (artificial ligament vs. endobutton) used Chi² or Fisher exact tests as appropriate for qualitative variables and Student or Mann-Whitney tests as appropriate for quantitative variables.

Displacement grades were correlated to functional scores on Kruskal-Wallis test.

Correlations between time to surgery and Constant score were assessed on Spearman correlation coefficient. Inter-examiner concordance was assessed on kappa coefficient.

Results

General Results

Mean age was 33.7 ± 8.4 years (range, 18.8-51.4 years), with male (25/26, 96%) and dominant side injured (66%). 86.4% (22/26) were "leisure" and 15.4% (4/26) "competitive" sports players. ACD was Rockwood grade 3 in 16/26 cases (61.6%), grade 4 in 8/26 (30.8%) and grade 5 in 2/26 (15.4%), secondary to a sports accident (17/26, 65.4%) or road accident (7/26, 26.9%). Mean time to surgery was 13.9 ± 9.8 days (range, 1-37 days). Mean follow-up was 26.6 ± 8.2 months (range, 13-47 months).

The 2 groups (artificial ligament vs. endobutton) were comparable on all preoperative parameters (Table 1).

Table 1: Comparison of the 2 surgical groups on preoperative parameters.

	Artificial ligament group (n=14)	Endobutton group (n=12)	p-value
Male/Female	14/0	11/1	0,28
Mean age (years)	33,4 (18-51)	34,0 (26-47)	0,13
Dominant side injured	60%	66,6%	0,76
Trauma-to-surgery time (days)	14,4	13,3	0,87
Rockwood grade 3/4/5	5/8/1	4/7/1	0,84
manual/office work	6/8	4/8	0,41
Body Mass Index	25 (20,6-30,1)	23 (19,3-29,8)	0,09
Sports level: leisure/competitive	12/2	10/2	0,06

All objective and subjective scores were “good” or “very good” at last follow-up: Constant-Murley = 94.1±4.8 (range, 75-98), UCLA’ac’ = 17.5±0.95 (15-18), SSV = 92.7±10.5 (50-100), Quick DASH = 275.2 ±93.2 (250-675). The rate of return to initial sports level was 76.9% (20/26), at a mean 20.8±6.7 weeks (range, 8.1-27.2 weeks). Time to surgery had no significant impact on Constant score at 1 year (p = 0.19) (Figure 1).

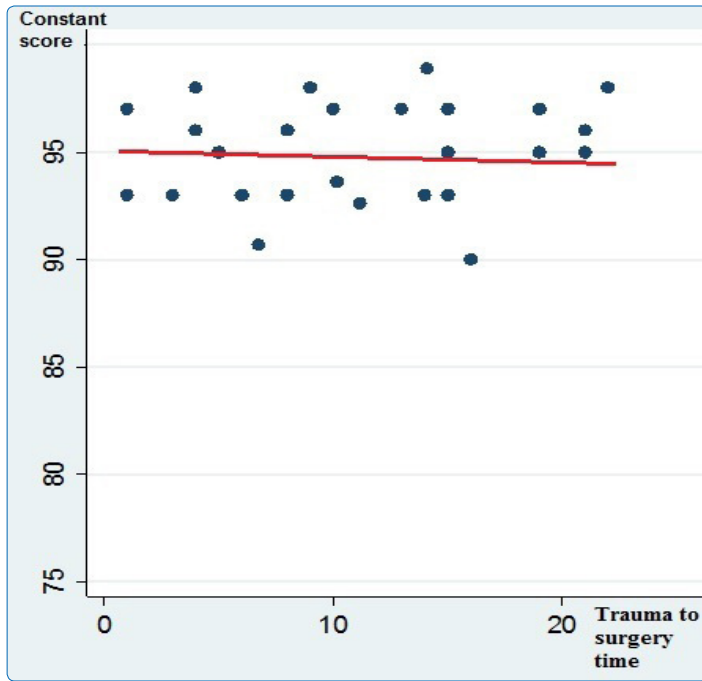


Figure 1: Correlation between trauma-to-surgery time (days) and

Constant and Murley score at final follow-up.

Radiologic analysis according to reduction quality showed that anatomic reduction was twice as frequent in the frontal plane (AP view) (6/26, 23.1%) as in the sagittal plane (lateral view) (3/26, 11.5%). Analysis of global reduction quality (poorest reduction score on AP or lateral view) found 42% (11/26) anatomic or good reduction, and 58% (15/26) partial or poor reduction (Table 2). Inter-examiner grading concordance was good: kappa >0.83.

Table 2: Analysis of the quality of the ACJ reduction at last follow-up on AP and lateral views and globally (i.e., poorest frontal or lateral reduction score).

Reduction quality group	Classification based on X-ray AP view	Classification based on X-ray lateral view	Classification based on X-ray ‘combined’ (AP+lat views)
Group 1 (anatomic)	6 (23%)	3 (12%)	1 (4%)
Group 2 (good: >80%)	7 (27%)	12 (46%)	10 (38%)
Group 3 (partial: 60-80%)	5 (19%)	6 (23%)	6 (23%)
Group 4 (poor: <60%)	8 (30%)	5 (19%)	9 (35%)
Group 5 (no reduction)	0	0	0

Correlation between Clinical and Radiological Results

Table 3 shows correlations between clinical and radiological results. All radiographic reduction groups were comparable on all preoperative parameters.

There were no significant differences in any clinical scores according to reduction quality (on AP lateral or combined views). Z-tendency tests found no significant decrease in clinical scores with decreasing reduction quality.

Table 3: Correlation between clinical and radiological results at final follow-up.

	Reduction group 1 (anatomic)	Reduction group 2 (good: >80%)	Reduction Group 3 (average: 60-80%)	Reduction group 4 (bad: <60%)	p-value	z-tendency	Degree of difference between groups
Classification based on X-ray AP view	N= 6	N= 7	N= 5	N= 8			
Constant score	96.3 (1.8)	91.1 (7.4)	95.8 (1.3)	94.1 (3.9)	p= 0.14	z= 0.54	p= 0.15
UCLA’ac’ score	17.7 (0.8)	17.4 (0.9)	17.2 (1.1)	17.6 (1.1)	p= 0.76	z= 0.96	p= 0.89
SSV	95.8 (3.8)	89.3 (17.9)	94.6 (2.9)	92.1 (9.2)	p= 0.48	z= 0.48	p= 0.95
Quick-DASH	250 (0)	282.9 (86.9)	250 (0)	303.1 (151.3)	p= 0.68	z= 0.56	p= 0.92
Classification based on X-ray lateral view	N= 3	N= 12	N= 6	N= 5			
Constant score	97.3 (0.6)	93.2 (6.2)	95.8 (1.7)	92.4 (3.7)	p= 0.06	z= 0.06	p= 0.06
UCLA’ac’ score	18.0 (0)	17.3 (0.9)	17.7 (0.8)	17.4 (1.3)	p= 0.67	z= 0.87	p= 0.84
SSV score	96 (1.7)	92.1 (7.9)	95.8 (2.0)	88.4 (10.5)	p= 0.14	z= 0.14	p= 0.94
Quick-DASH	250 (0)	269.2 (66.4)	250 (0)	335 (190.1)	p= 0.60	z= 0.40	p= 0.37
Classification based on X-ray ‘overall’ (AP+lat views)	N= 1	N= 10	N= 6	N= 9			
Constant score	97 (0)	92.7 (6.7)	96.5 (1.4)	93.9 (3.4)	p= 0.20	z= 0.67	p= 0.21
UCLA’ac’ score	18.0 (0)	17.6 (0.8)	17 (1.1)	17.7 (1.0)	p= 0.42	z= 0.98	p= 0.68
SSV score	95 (0)	91.5 (15.3)	96.3 (2.2)	91.3 (8.2)	p= 0.45	z= 0.27	p= 0.98
Quick-DASH	250 (0)	273 (72.7)	250 (0)	297.2 (141.7)	p= 0.85	z= 0.81	p= 0.50

Comparison between groups 1 + 2 (“anatomic and good reduction”) and 3 + 4 (“moderate and poor reduction”) found no significant differences on any clinical scores (Constant-Murley: p = 0.53; UCLA’ac’: p = 0.86; SSV: p = 0.14; Quick DASH: p = 0.33).

Clinical Scores and Radiologic Parameters According To Surgical Technique

The 2 surgical technique groups (artificial ligament vs. endobutton) showed comparable functional results, with no significant differences (Table 4).

Table 4: Clinical and functional results of the 2 surgical groups at final follow-up.

	Artificial ligament group (n=14)	Endobutton group (n=12)	p-value
Constant-Murley score	94.5 (86-98)	17.5 (16-18)	0.29
UCLA 'ac' score	17.1 (15-18)	17.5 (16-18)	0.82
SSV	92.8 (70-100)	91.6 (67-100)	0.42

Table 5: Analysis of the quality of the ACJ reduction at last follow-up on AP and lateral views and globally (i.e., poorest frontal or lateral reduction score) depending of the surgical group.

Reduction quality group	Artificial ligament group (n=14)			Endobutton group (n=12)		
	AP view	Lateral view	AP+Lat views	AP view	Lateral view	AP+Lat views
Group 1 (anatomic, 100%)	0	2 (14%)	0	6 (50%)	1 (8%)	1 (8%)
Group 2 (good, >80%)	2 (14%)	3 (21%)	2 (14%)	5 (42%)	8 (67%)	8 (67%)
Group 3 (partial, 60-80%)	5 (36%)	4 (28%)	4 (28%)	0	2 (17%)	1 (8%)
Group 4 (poor, <60%)	7 (50%)	5 (36%)	8 (56%)	1 (8%)	1 (8%)	2 (17%)
Group 5 (no reduction)	0	0	0	0	0	0

Discussion

The study hypothesis was not confirmed: there were no significant correlations between radiologic reduction quality and clinical or functional results: i.e., significant radiologic/clinical discordance.

The study had obvious limitations and biases. The design was retrospective, with low power. However, the number of patients (n=26) followed up beyond 2 years was at least comparable to that in most other studies, and establishing preoperative inter-group comparability limited some of the bias [9]. The radiologic analysis is open to criticism. Reproducibility was analyzed and appeared to be good regarding displacement in the frontal plane on AP view, but less so on the horizontal plane on lateral view, double analysis was therefore performed, measuring coracoclavicular displacement on AP view and classifying reduction quality on AP and lateral views, by 2 independent examiners. Analysis of postoperative displacement on AP view according to time to surgery is considered to be the most valid [9]. Lateral analysis is certainly less precise, but has the advantage of being simple and reproducible (kapa >0.80) and corresponding to actual everyday practice.

Analysis of radiologic progression (Figure 2) showed significant reduction loss during the early postoperative course (first 45 days) in the artificial ligament group. One reason for this may be that the material itself involves a certain elasticity of assembly, with a considerable length of synthetic tissue; another concerns the surgical technique, without any real clavicle fixation (the artificial ligament is "tying" the clavicle) and hence with possible micro movement in this area. In contrast, exclusively coracoclavicular reconstruction using a single endobutton with cortical support is sufficiently rigid and resistant to maintain reduction during this ligament healing phase. This was confirmed by Beitzel in a cadaver study of tear resistance in various types of reconstruction, the coracoclavicular endobutton technique showed resistance

Quick-DASH	89 (24-100)	75 (24-95)	0.96
Rate of return to sport at initial level	70%	77.8%	0.70
Complications	3 (2 infections, 1 stiffness)	2 (1 superficial wound infection, 1 thrombosis)	0.29

Immediate postoperative reduction quality was similar on the 2 techniques (p= 0.15). Over the first 6 weeks, the artificial ligament group showed about 30% reduction loss, stabilizing thereafter; this pattern was not seen in the endobutton group (Figure 2) (p= 0.02). Moreover, reduction quality classification at 1 year (anatomic or good vs. moderate or poor) showed a significant difference (p = 0.02) in favor of the endobutton technique (Table 5).

equivalent to that of the native joint and greater, for example, than modified Weaver-Dunn reconstruction [13]. Adding a second endobutton did not increase mechanical resistance but on the contrary increased risk of fracture [14-17].

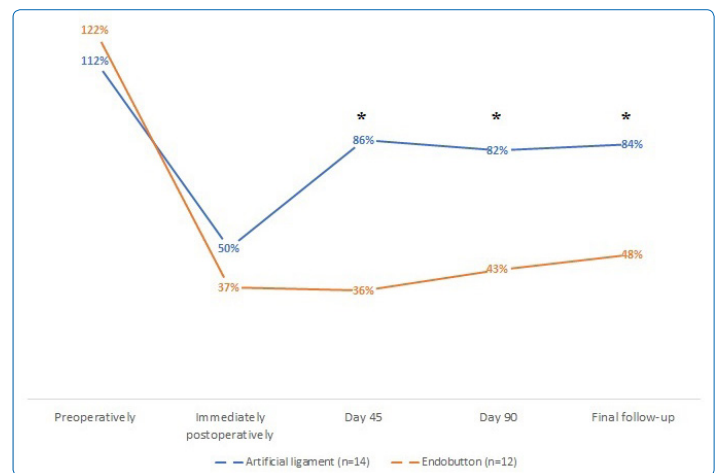


Figure 2: Evolution of the frontal reduction of the ACJ on AP view (%) all along the follow-up (*: significant difference).

The impact of reduction quality on functional outcome remains controversial. According to biomechanical studies, anatomic acromioclavicular reconstruction (associated to coracoclavicular reconstruction) is essential for force transmission in compression and rotation ("strut function") in overhead movement [18, 19]. Voss confirmed that anatomic reduction or slight (3 mm) under-correction on AP view of the acromioclavicular joint restores physiological joint stress [20]. However, clinical benefit was not proven in a recent meta-analysis, and with only a weak correlation coefficient in the study by Barth et al. [21-22]. This is in line with

some of the literature finding no superiority for surgery over non-operative treatment (i.e., without anatomic reduction) even in high-grade dislocation [5, 23-25].

Conclusion

Anatomic reduction would not seem to be mandatory for good functional results in grade 3-5 acute ACD. "Simple" coracoclavicular endobutton reconstruction suffices to obtain and stabilize near-normal reduction enabling ligament healing.

Conflict of Interest: S. Boisgard is a consultant for Zimmer-Biomet. All the authors except A. Mulliez and P. Métais participate in Ostéobanque on a voluntary basis, without compensation. The authors declare no conflict of interest with this study.

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