Original Article

Unstable acromioclavicular joint injuries: Is there really a difference between surgical management in the acute or chronic setting?

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ABSTRACT

Aim: To compare the outcomes of unstable ACJ injuries managed with an arthroscopy-assisted anatomic reconstruction of the coracoclavicular (CC) ligaments in the acute and chronic setting.

Methods: A retrospective revision was performed. The SF36, visual analog scale for pain, DASH questionnaire, constant score and the global satisfaction were assessed at the last follow-up visit.

Results: 22 patients were included. Results of the questionnaires assessed at the last follow-up visit showed no significant differences between the study groups.

Conclusion: Management of ACJ injuries in the acute or chronic setting may involve comparable outcomes if biological and mechanical aspects are considered.

Level of evidence: Level III, retrospective cohort study.

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1. Introduction

Surgical management of acute unstable acromioclavicular joint (ACJ) injuries should be focused on realigning the torn ends of the ligaments, because it is accepted that in the acute phase they still have healing potential.¹ On the other side, surgical management of chronic ACJ injuries should incorporate a biological augmentation, because it is accepted that after 3 weeks from shoulder injury the AC and the CC ligaments have lost their property to heal.²

Previous studies that compared the surgical management in the acute setting versus surgical management in the chronic setting suggest that better outcomes may be obtained from early management.^{1,3} Surgical techniques performed in these studies were non-anatomic procedures, which incorporated temporary metal hardware, both for patients managed in the acute and chronic setting.^{1,3}

It has been reported that non-anatomic procedures may involve worst clinical and radiological outcomes than anatomic ligaments

reconstructions.⁴ It has been also reported that reconstructions with tendon allograft for chronic injuries tend to involve partial loss of reduction with follow-up because elongation of the graft.⁵ It is actually clear that outcomes depend on the technique performed.⁶

As far as we have knowledge, there are not studies that provide comparative evidences regarding the outcomes of unstable ACJ injuries managed with an anatomic reconstruction of the CC ligaments in the acute setting versus those injuries managed in the chronic setting.

The aim was to provide evidences about the clinical and radiological outcomes of unstable ACJ injuries managed with an arthroscopy-assisted anatomic reconstruction of the coracoclavicular (CC) ligaments in the acute and chronic setting.

We hypothesized that patients with unstable ACJ injuries managed with an anatomic reconstruction of the CC ligaments performed in the acute setting by means of two CC suspension devices anatomically placed, would have similar outcomes than patients with unstable ACJ injuries managed with an anatomic reconstruction of the CC ligaments performed in the chronic setting by means of a CC ligaments reconstruction with a tendon allograft, protected by a primary mechanical stabilizer during the integration process of the graft to the bone tunnels.

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2. Patients and methods

2.1. Study design

A retrospective cohort study was performed in two tertiary hospitals. Patients with unstable ACJ injuries (grade IIIB–V according to the modified Rockwood classification) managed by means of an anatomic reconstruction of the CC ligaments arthroscopy-assisted, performed in the acute and chronic setting were included. The inclusion period ran from January 2011 to January 2013.

2.2. Study population

Patients were included in the study following these inclusion criteria: (a) either sex; (b) radiographic diagnosis of unstable ACJ injury (Rockwood IIIB–IV–V); (c) physically active and between 18 and 55 year-old at the moment of shoulder surgery; (d) managed operatively by means of an arthroscopy-assisted CC reconstruction with two suspension devices (ACUTE-group) or by means of an arthroscopy-assisted CC reconstruction with a tendon allograft plus a suspension device (CHRONIC-group); (e) with a clinical history and radiological examination complete and available at the moment of the revision of the records; (f) with a minimum follow-up of 24 months after surgery and (g) operated by the same shoulder surgeon. The exclusion criteria were: (a) radiographic diagnosis of an ACJ injury Rockwood grade I–II–IIIA; (b) previous injuries to the respective shoulder and (c) surgical techniques other than acute or chronic arthroscopically assisted anatomic CC reconstruction. The patients who fulfilled these eligibility criteria were contacted and proposed to be included in the study. Once patients accepted to participate in the study, they signed an informed consent, and radiographic and clinical examinations of the injured shoulder were collected.

2.3. ACJ injury classification

Classification was made by means of observing the X-rays performed at the initial visit post injury. Radiographic examinations of both shoulders were performed to all patients at the initial visit post injury. The X-rays protocol of these two institutions included: strict anteroposterior (AP) view (both shoulders), Zanca view (both shoulders) and axillary view (only injured shoulder). Axillary views were performed with the patient in the prone position. The cross-body adduction view (Alexander view) was performed at the initial visit post injury in all patients, so in accordance to the diversification of the Rockwood classification proposed by ISAKOS,⁷ the classification could be updated as it was done previously.⁸ Rockwood IIIB injuries were those in which there was evidence of the clavicle overriding the acromion in the Alexander X-rays.⁷

Grade III and grade V injuries were differentiated according to the traditional Rockwood classification.⁹ A grade III if the CC distance of the injured shoulder was increased between 25 and 100% when compared to the non-injured shoulder; and a grade V if the CC distance of the injured shoulder was increased between 100 and 300% when compared to the non-injured shoulder.⁹ These assessments were made on Zanca views. Diagnosis of ACJ injuries Rockwood grade IV was made by means of observation in the axillary view of the clavicle posteriorly dislocated in relation to the acromion.⁹

2.4. Clinical assessments and quality of life (QoL) evaluations

The clinical outcomes and the QoL were evaluated by means of the Health Survey questionnaire (SF36), the visual analog scale

(VAS) for pain, the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, the constant score and the global satisfaction (scale from 0 to 10), assessed at the last follow-up visit.

2.5. Management decision-making

There was no randomization before decision-making. Patients with acute unstable ACJ injuries Rockwood grade IV–V (Fig. 1A) were told that there were international recommendations regarding the surgical management for this type of injuries¹¹; and patients with Rockwood grade III ACJ injuries were told that there were no evidence-based medical guidelines for decision-making and that surgery was recommended in active patients with high demands on the shoulder function. In summary, indications were based on the radiological magnitude of displacement between the clavicle and the acromion, which at the end is the indicator of a tear or not in the CC ligaments with affection or not of the deltotracheal fascia,^{10,11} which also plays a determinant role in the vertical and horizontal stability of the ACJ.¹²

Once the diagnosis unstable ACJ injury was established, patients were informed about the different treatment options. The timeline between acute and chronic injuries, as well as the surgical technique, were established according to current international consensus.⁶ Acute injuries were managed with two CC suspension devices anatomically placed within the first three weeks after injury (Fig. 1B), and chronic injuries were managed with tendon graft augmentation after three weeks from shoulder injury (Fig. 1C and D). Patients who at the initial visit post injury at the shoulder clinic, agreed to undergo for surgical management were included in the ACUTE-group. Patients of the CHRONIC-group were those who initially rejected surgery in the acute setting, thus were initially managed conservatively. After a period of conservative measures with no remission of the symptoms these patients were proposed to have surgery in the chronic setting. Patients of both groups were told about the risks of a surgical intervention.

2.6. Surgical technique

2.6.1. ACUTE-group

The performed technique involves the placement of two CC suspension devices by means of an arthroscopy-assisted procedure. This technique has been previously described adding an ACJ horizontal augmentation.¹² In the series of patients of this study, no horizontal augmentation was performed.

The coracoacromial (CA) ligament is followed until its insertion at the coracoid. The base of the coracoid is cleaned with a vaporizer. The suspension devices are passed through the tunnels in a retrograde direction. The retrograde direction (from coracoid to clavicle) implies making CC tunnels with a diameter of 3.5 mm, thus minimizing the probability of coracoid fracture. A transverse incision with a length of 3 cm is made 2 cm medial to the lateral edge of the clavicle. This incision is made between the locations where the native origins of the conoid and trapezoid ligaments should be in the inferior aspect of the clavicle. The native origin of the conoid is 4.5 cm medial to the lateral edge of the clavicle, and the trapezoid is 2.5 cm and slightly anterior when compared with the conoid.¹³ A cross section of the deltotracheal fascia is performed. The traction is released, and a Biomet AC drilling guide (reference 909511) with a calibrated angulation of 80 to 90 is placed at the base of the coracoid, adjacent to the wall of the scapula, and 5 mm lateral to the medial border of the coracoid, with the sliding tube of the guide located in the superior aspect of the clavicle, 4.5 cm medial to the ACJ (conoid native origin) (Fig. 2A). A 2.4-mm K-wire is passed through the AC guide. The location of the AC guide is then changed. In the inferior aspect of the coracoid, the AC guide is placed 5 mm medial to the lateral

Fig. 1. (A) Anteroposterior X-ray of a left shoulder in which an ACJ injury Rockwood grade V can be observed. (B) Anteroposterior X-ray of a left shoulder in which an anatomic CC fixation with two suspension devices was performed in the acute setting. (C) Anteroposterior X-ray of a left shoulder in which an ACJ injury Rockwood grade V can be observed. (D) Anteroposterior X-ray of a left shoulder in which an anatomic reconstruction of the CC ligaments with tendon allograft was performed in the chronic setting. Observe the trapezoid tunnel in clavicle, lateral to the conoid tunnel in clavicle, through which also passes the suspension device.

Fig. 2. (A) Posterior perspective of a left shoulder in which the AC guide is being introduced through the anterior portal with the sliding tube supported in the superior aspect of the clavicle. The arthroscope is introduced through the anterolateral portal. (B) AC sawbone in which the conoid K-wire has been already passed, and the AC guide is supported in order to allow the placement of the trapezoid K-wire. (C) Superior perspective of an AC sawbone in which the two K-wires placed in the anatomic locations of the CC ligaments can be observed. (D) Subcoracoid vision of a right shoulder through the anterolateral portal. Observe the two CC K-wires coming out from the coracoid. The conoid K-wire (red arrow) is more posterior and medial than the trapezoid K-wire (blue arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

border of the coracoid and slightly anterior when compared with the location of the conoid K-wire. In the superior aspect of the clavicle, the sliding tube should be located in the trapezoid native origin, which is 2.5 cm medial to the ACJ and slightly anterior when compared with the location of the previous K-wire.

A 2.4-mm K-wire is passed from the clavicle to the coracoid, following the anatomic orientation of the trapezoid ligament (Fig. 2B). From the superior aspect of the clavicle, convergence of the two K-wires can be observed (Fig. 2C). The distance between K-wires in the inferior aspect of the coracoid should be about 1.5 cm (Fig. 2D). Afterward, a 3.5-mm cannulated drill is passed over the conoid K-wire until it comes out from the inferior aspect of the coracoid, where the AC guide catches it. The conoid K-wire is removed, and the cannulated drill is kept in position. A shuttle suture (1-mm PDS; Ethicon, Somerville, NJ) is passed from the clavicle to the coracoid through the cannulated drill and is then recovered with a grasper from the anterior portal. A No. 2 MaxBraid suture (Arthrotek [Biomet]) is tied to the distal limb of the PDS that passes through the conoid tunnel, and the PDS is then pulled out cranially to make the shuttle MaxBraid pass through the tunnel. Next, the 3.5-mm cannulated drill is passed over the trapezoid K-wire. The trapezoid K-wire is removed, and the cannulated drill is kept in position. Another 1-mm PDS shuttle suture is passed from the clavicle to the coracoid through the cannulated drill and is recovered with a grasper from the anterior portal. A No. 2 MaxBraid suture is tied to the distal limb of the PDS that passes through the trapezoid tunnel, and the PDS is then pulled out cranially to make the shuttle MaxBraid pass through the tunnel. The conoid suspension device (ZipTight, reference 904834; Biomet) is first passed through the tunnel. The distal limb of the conoid shuttle MaxBraid is provisionally tied to the sliding sutures of the suspension device. This shuttle MaxBraid, which is coming out from the conoid tunnel in the clavicle, should be pulled out

cranially to make the suspension device pass through the tunnel (Fig. 3A). The same procedure is repeated in the trapezoid tunnel. Once both suspension devices have been passed through each tunnel, the titanium flip devices of both are properly placed in the inferior aspect of the coracoid (Fig. 3B). Before tensioning of the ZipTights is performed (Fig. 3C), the sliding sutures of the system should be threaded in the washers to make them descend until they touch the clavicle. Afterward, the surgical assistants should reduce the ACJ by pushing the elbow upward and the clavicle downward at the same time. Once the flip device of the conoid ZipTight has been properly supported in the inferior aspect of the coracoid, it is tied and fixed by pulling alternatively on both limbs of the sliding sutures in a cranial direction to make the washer go down until it touches the clavicle and self-locks. Now fixation and locking of the trapezoid ZipTight can be performed. Both ZipTights are completely fixed by pulling alternatively on both limbs of the sliding sutures in a cranial direction. Once the 2 ZipTights have been locked (Fig. 3D), the final CC interval reduction can be checked with intraoperative radiographs. The ACJ reduction is checked by direct palpation, direct arthroscopic visualization, or intraoperative radiographs. The remnants of the sliding sutures are now cut. The deltotrapezial fascia is carefully closed and reconstructed with No. 1.0 Vicryl (Ethicon).

2.6.2. CHRONIC-group

This arthroscopy-assisted technique has been previously described.¹⁰

Anatomic reconstruction of the CC ligaments using a semi-tendinosus tendon allograft was performed in all patients. The technique involves one tunnel at the coracoid, and two tunnels at the clavicle. These tunnels are aimed to emulate the anatomical locations of the CC ligaments. We also add a CC suspension device in order to guarantee the primary stability of the reconstruction.

Fig. 3. (A) AC sawbone in which the conoid CC suspension device is being passed in a retrograde direction. This suspension device is being pulled out from the superior aspect of the clavicle. (B) Subcoracoid vision of a right shoulder through the anterolateral portal. Observe the two subcoracoid flips of the two suspension devices. (C) Superior perspective of a left shoulder in which the sliding sutures of both suspension devices can be observed after have being passed in a retrograde direction. (D) Superior perspective of a left shoulder in which the washers of both suspension devices can be observed.

We perform an arthroscopy-assisted reconstruction in order to be able to diagnose and treat possible associated glenohumeral injuries, and in order to have a proper view of the inferior aspect of the base of the coracoid at the moment of drilling the tunnel.

A subacromial approach to the base of the coracoid is performed. A Mumford procedure is associated. A transverse skin incision over the clavicle is performed. The conoid native insertion is 4.5-cm medial to the distal end of the clavicle and the trapezoid native insertion 2.5-cm and subtly anterior when compared to the conoid.¹³ A cross section of the deltotracheal fascia is performed, and the AC drilling guide is placed at the base of the coracoid with the sliding tube at the superior aspect of the clavicle, 4.5-cm medial to its distal end (conoid native origin). A K-wire is passed through the cannulated drill. The K-wire is removed and the cannulated drill is maintained in the same position. A shuttle suture is passed through the cannulated drill. Two metal-core sutures (No. 2 MaxBraids) are tied to the distal end of the PDS that passes through the coracoid. Subsequently, the same procedure should be performed, this time for the clavicular tunnel of the trapezoid ligament. One of the metal-core sutures that pass through the conoid tunnel is temporarily tied to one of the ends of the tendon graft. The other end of the graft is temporarily tied to the PDS, which is coming out from the trapezoid clavicle and exits through the anterior portal.

The graft is passed by means of pulling cranially of the metal-core suture that comes out from the conoid tunnel. Subsequently, the PDS which is coming out from the trapezoid clavicle tunnel is pulled in a superior direction; so the graft is directed laterally and superiorly, conforming the anatomic “V” configuration of the reconstruction (Fig. 4A). One of the ends of the shuttle metal-core suture is still free in the conoid tunnel. This suture is now tied to

the CC suspension device, and pulled out in a cranial direction so the device passes in a retrograde direction (Fig. 4B). The washer should be threaded with the sliding sutures, in order to be able to bring it down until it is applied over the clavicle. In the inferior aspect of the coracoid the subcoracoid flip of the suspension device should be properly supported (Fig. 4C). The assistants must reduce the ACJ, by means of pushing the elbow upwards and the clavicle downwards at the same time. Posteriorly, the graft is fixed in the clavicular portion of the tunnels with biotenodesis interferential screws. The CC suspension device is now locked (Fig. 4D). The deltotracheal fascia is carefully reconstructed.

The described technique provides the advantages of a minimally invasive surgery, avoids the biomechanical disadvantages related to rigid metal hardware procedures, offers a greater biomechanical resistance thus minimizing the risk of secondary displacements related to non-anatomical techniques, and combines a primary mechanical stabilization and a definitive biological stabilization represented by the graft, once integrated to bone. In Fig. 1D, the radiological aspect of a left shoulder in which the described technique was performed can be appreciated.

2.7. Rehabilitation period

The rehabilitation period involved wearing a sling for 3–4 weeks. Patients were initially allowed to move fully and actively the elbow, wrist, and hand. In both groups, pendulum exercises begin from the first week post-injury, and patients were allowed to passively move the shoulder no more than 90° of elevation in the plane of the scapula after the first week. The active range of motion was progressively advanced from the sixth week onwards in both groups. Exercises to regain strength were initiated once the patient

Fig. 4. (A) Subcoracoid vision of a right shoulder through the anterolateral portal. Observe the tendon allograft coming from the conoid tunnel in the coracoid. This tendon is being pulled from the trapezoid tunnel in clavicle. The red arrow is pointing the shuttle suture, which is going to be used to pass the suspension device. (B) Superior perspective of a right shoulder in which the two limbs of the tendon allograft are being pulled cranially (red arrow). The suspension device is tied to the shuttle suture (white arrow), which is also being pulled cranially from the superior aspect of the conoid tunnel in clavicle. (C) Subcoracoid vision of a right shoulder through the anterolateral portal. Observe the tendon allograft coming out from the conoid tunnel and surrounding the coracoid before ascending to the trapezoid tunnel in clavicle. The subcoracoid flip of the suspension device is properly supported. (D) Superior perspective of a right shoulder in which the final aspect of the construction can be observed.

had full, pain-free passive and active range of motion, and exercises were primarily directed toward scapular stabilization. Return to work without restrictions was allowed after 12–14 weeks and contact sports or major efforts were avoided for 4–6 months in both groups.

2.8. Radiographic follow-up

Radiographic follow-up evaluations were made based on the X-rays performed at the last follow-up visit. Radiographic examinations of both shoulders were performed. The X-rays included the same protocol performed at the initial visit post injury: strict AP view (both shoulders), Zanca view (both shoulders), axillary view (only injured shoulder) and cross-body adduction view (Alexander view).

Remaining vertical ACJ instability was assessed on bilateral Zanca views, according to the modified Rosenørn and Pedersen classification.¹⁴ The ACJ was considered reduced when there was no displacement in comparison to the non-injured side, subluxed when there was less than 50% of displacement of the clavicle in relation to the height of the acromion and completely dislocated if the displacement of the clavicle was greater than 50% of the height of the acromion. We did not measure the CC distance. Remaining horizontal instability was assessed by means of observation of the clavicle overriding the acromion in the Alexander X-rays performed at the last follow-up visit.

2.9. Assessment of scapular motion and complications

Scapular dyskinesis was diagnosed according to Kibler's definition, as the alteration of the normal position or motion of the scapula during coupled scapulohumeral movements.¹⁵ The presence of scapular dyskinesis was assessed at the last-follow up visit, by means of the "yes/no" method described by Kibler's group.¹⁶ This test consists on the evaluation of the scapular motion by the physician when the patient is performing shoulder forward flexion with both shoulders. It is a simplification of the Kibler's 4-type method, and groups dyskinesis categories (types I to III) into a single category of "yes" (presence of dyskinesis), and type IV is labeled as "no" (normal scapular motion). Comparison between groups was performed.

Coracoid fracture, development of hardware irritation and infections were registered.

3. Statistical analysis

The sample was conformed by all of the patients of the study period who fulfilled the inclusion criteria. There was not a previous estimation of the population. Statistical analysis was carried out according to the complete sample analysis.

Continuous variables are presented as mean and standard deviation (SD) or mean and range. Categorical variables are presented as percentages and frequencies. The relationship between variables was analyzed with contingency tables for the categorical ones, and the inference was studied with the X^2 test or Fisher's exact test depending on what corresponded. The Mann–

Whitney U test was applied to analyze quantitative variables. Descriptive statistics, such as percentage and median with interquartile range (IQR, 25th to 75th percentile) were used to analyze data on subjective and objective shoulder function.

Comparison between treatments was performed regarding only the injured shoulder. Comparisons between the function of the injured shoulder and the uninjured one were not performed. The level of significance was set at 5% ($\alpha = 0.05$). Data were analyzed by use of the SPSS 19 (SPSS Inc., Chicago, IL).

4. Results

4.1. Population characteristics

22 patients were included: 12 ACUTE-group (3 Rockwood IIIB, 2 IV and 7V) and 10 CHRONIC-group (1 Rockwood IIIB, 1 IV, and 8V). The mean age was 31 (range 19–45) year-old in the ACUTE-group and 41 (range 33–55) in the CHRONIC-group ($p = 0.0001$). All patients were men. The mean time elapsed from shoulder injury to surgery was 8 days (range 5–15) in the ACUTE-group, and 203 days (range 46–354) in the CHRONIC-group ($p = 0.0001$). The mean follow-up after surgery was 26.50 months (range 25–32) in the ACUTE-group and 25.50 months (range 24–30) in the CHRONIC-group ($p = 1.000$). The mean time elapsed from shoulder injury to the last follow-up visit (moment of study assessments) was 26.80 months (range 25–33) in the ACUTE-group and 32.25 months (range 30–36) in the CHRONIC-group ($p = 0.003$). Table 1 shows the baseline characteristics of the study population by treatments groups.

4.2. Associated concomitant glenohumeral injuries

Concomitant glenohumeral injuries were detected and treated in 16.67% (2/12) of the patients of the ACUTE-group (2 slap lesions type II) and in 20% (2/10) of the patients of the CHRONIC-group (1 Bankart and 1 slap lesion type II) ($p = 1.000$). These injuries were managed by means of fixation with suture-anchors.

4.3. Quality of life evaluations

These results are presented in Table 2.

4.4. Radiographic follow-up

At the last follow-up visit, there was evidence of remaining vertical instability in 8.33% (1/12) patients of the ACUTE-group and in none of the patients of the CHRONIC-group ($p = 1.000$). There was evidence of remaining horizontal instability in 16.67% (2/12) of the patients of the ACUTE-group and in 20% (2/10) of the patients of the CHRONIC-group ($p = 1.000$).

4.5. Scapular dyskinesis

At the last follow-up visit, there was evidence of scapular dyskinesis in 8.33% (1/12) of the patients of the ACUTE-group and in 10% (1/10) of the patients of the CHRONIC-group ($p = 1.000$).

Table 1
Baseline characteristics of patients by treatment groups.

		Total (n = 22)	ACUTE-group (n = 12)	CHRONIC-group (n = 10)	P value
Age (year-old)	Mean [range]	35 [19–55]	31 [19–45]	41 [33–55]	0.0001
Time from injury to surgery (days)	Mean [range]	95 [5–354]	8 [5–15]	203 [46–354]	0.0001
Mean follow-up after surgery (months)	Mean [range]	26 [25–32]	26.50 [25–32]	25.50 [24–30]	1.000
Time elapsed from shoulder injury to last follow-up visit (months)	Mean [range]	29.5 [25–36]	26.80 [25–33]	32.25 [30–36]	0.003

Table 2
Quality of life results.

Quality of life evaluations.	ACUTE-group	CHRONIC-group	P value
SF36 physical	58.33 ± 1.15	59.58 ± 1.98	0.085
Mean ± SD			
Median [P ₂₅ –P ₇₅]	58 [56.5–60]	59 [57.5–62]	
SF36 mental	55.25 ± 1.76	56.62 ± 1.89	0.103
Mean ± SD			
Median [P ₂₅ –P ₇₅]	55 [54–57]	57 [56–58]	
VAS	0.92 ± 0.79	1.44 ± 1.74	0.361
Mean ± SD			
Median [P ₂₅ –P ₇₅]	1 [0–1.75]	1 [0–2.5]	
DASH	3.80 ± 2.52	2.61 ± 1.79	0.244
Mean ± SD			
Median [P ₂₅ –P ₇₅]	3.1 [2.05–3.85]	1.70 [1.35–4.6]	
Constant score	95.50 ± 2.58	95.56 ± 3.28	0.966
Mean ± SD			
Median [P ₂₅ –P ₇₅]	96 [94–98]	96 [93–98]	
Global satisfaction	8.5 ± 0.9	9.2 ± 0.67	0.058
Mean ± SD			
Median [P ₂₅ –P ₇₅]	8 [8–9]	9 [9–10]	

4.6. Complications

There was no any case of coracoid fracture, hardware irritation or infection or in any of the treatment groups.

5. Discussion

The main finding of this study was that patients with unstable ACJ injuries managed with an anatomic reconstruction of the CC ligaments in the acute setting have the same quality of life and radiological outcomes than patients managed with an anatomic reconstruction of the CC ligaments with tendon allograft plus a primary mechanical stabilizer in the chronic setting.

Unstable ACJ injuries managed with arthroscopy-assisted procedures have shown good and excellent clinical outcomes.¹⁷ Diagnosis and treatment of concomitant glenohumeral injuries and no mandatory implant removal are the main advantages of arthroscopy-assisted techniques among open procedures.^{17,18} As far as we have knowledge, this is the first comparative report in regards to associated intraarticular injuries in the acute and chronic setting.

Warren-Smith and Ward analyzed 32 patients with Allman grade 3 ACJ injuries managed with the Weaver–Dunn procedure.¹⁹ There were no differences between the 10 early and the 22 late patients; but authors concluded that surgery was technically easier when performed in the acute setting. Their study showed excellent functional results in 67% (6/9) of the patients treated in the acute setting and in 55% (11/20) of the patients treated in the chronic setting.¹⁹ We agree with authors in the technical aspects. In the chronic setting reduction of the ACJ is more difficult, and it often involves the need of associate a Mumford procedure.

Weinstein et al. described the time point distinguishing acute versus delayed surgery, as 3 weeks from the date of injury.² In their comparative study the surgical procedure used was the modified Weaver–Dunn technique in 55.56% (15/27) of the cases managed in the acute setting and in 82.35% (14/17) of the cases managed in chronic setting. The rest of the repairs were performed by means of AC non-reabsorbable sutures. Satisfactory results were obtained in 96% of the cases treated in the acute phase and in 76% of the cases treated in chronic phase. The differences were statistically significant in favor of the treatment in the acute phase.² 44.44% (12/27) of the patients of the acute group and 17.67% (3/17) of the patients of the chronic group were managed by means of an AC fixation with sutures (horizontal stabilization). We believe that differences between outcomes of these groups could rely on the differences in the number of patients that received a horizontal

stabilization, taking in consideration that horizontal instability is a risk factor for a poor clinical outcome.²⁰

Rolf et al. compared a group of patients treated immediately after occurrence of shoulder injury (29 patients, using the modified Phemister technique, adding a CC fixation with sutures) versus a group of patients that had surgery after failure of conservative treatment (20 patients using the modified Weaver–Dunn procedure).¹ Clinical results were significantly superior in the group of patients managed in the acute phase.¹ Biomechanical studies have shown the inferior resistance to vertical loads of the Weaver Dunn procedure when compared to CC fixation with sutures.²¹ We believe that differences encountered in the study performed by Wolf et al. might be in relation to the currently known biomechanical disadvantages of the Weaver Dunn procedure.²¹

Mignani et al. compared 25 patients treated in the acute setting versus 15 patients in treated in the chronic setting.²² In both groups the management consisted on AC and CC temporary fixations with Kirschner wires and concomitant excision of the distal third of the clavicle. Authors reported satisfactory results in 100% of the patients of the acute group and 93% in the patients of the chronic group, with no statistically significant differences.²² In this study, no biological augmentation was added in the group of patients managed in the chronic setting, so we believe this condition could influence the worst outcomes registered in the chronic group, even though the differences did not reach statistical significance. If a biological augmentation is not incorporated in chronic ACJ injuries, it may be perfectly expected that patients managed in the acute setting have better outcomes.

Dumontier et al. compared 32 patients treated in the acute setting (first 3 weeks) versus 24 patients treated in the chronic setting (over 3 weeks).²³ All patients were managed by means of the Weaver–Dunn procedure. The results were satisfactory in 81% of the patients treated in the acute setting and in 79% of the patients treated in the chronic setting.²³ The study reported no significant differences between groups. We believe that registered outcomes were quite similar between groups, because in the group managed in the chronic setting a biological augmentation was incorporated (CA ligament), and in the group managed in the acute setting the transposition of the CA ligament could have been useful to narrow the CC space, thus favoring the healing of the native structures.

Von Heideken et al. compared 22 patients managed in the acute setting (within the first 4 weeks after injury) versus 15 patients managed in the chronic setting (after a minimum of 4 months of conservative measures).³ The technique used was the ACJ fixation with a hook plate. In the acute group, the remnants of the ligaments were brought in vicinity by the reduction of the clavicle with the hook plate. In the chronic group, a modified Weaver Dunn procedure augmented with a hook plate was used. The results favored significantly both in the clinical and radiological aspects, to the group of patients who were managed in the acute setting.³ We believe that these differences might be the reflection of the biomechanical superiority of the native CC ligaments over the translocated CA ligament.²⁴ In our study, it can be said that the registered outcomes involve a comparison between the healed native CC ligaments and the tendon-reconstructed CC ligaments. In fact, it has been shown that the biomechanical behavior of a CC ligaments reconstruction with tendon allograft is superior to the native CC ligaments.²⁴

Millet et al. compared the outcomes of patients who underwent delayed CC reconstruction (more than 30 days) when compared with those who underwent early reconstruction CC (less than 30 days).²⁵ In their study the whole population consisted on 31 patients with Rockwood grade III and grade V ACJ injuries, but they do not specify the number of patients included in each group. Authors performed the same technique in all shoulders. The

technique consisted on an anatomic CC reconstruction with a tibialis anterior or peroneus longus tendon allograft implanted by either an open or arthroscopically assisted procedure. Patients who underwent early reconstruction showed no significant differences in postoperative clinical or radiographic results when compared with those who underwent delayed reconstruction. We believe that in this study the registered outcomes were similar between groups because in the group managed in the chronic setting a biological augmentation was incorporated. Considering that it is accepted that in the acute setting the native structures have healing potential, a biological augmentation with a tendon allograft might be saved; but this study shows that if an anatomic reconstruction with a biological augmentation is performed, the expected outcomes may be the same independently of the timing for surgery.

It has been shown that radiographic results (maintenance of the reduction of the ACJ and the CC interval) obtained by means of the management in the acute phase may be better than those obtained in the chronic phase.^{1,3} It has been reported that tendon grafts tends to lengthen over time; and besides, they may emulate a “windshield” effect at the level of the clavicular tunnels, situation that eventually ends with widening of the tunnels.²⁶ In a previous study in which patients treated in the acute phase were managed by means of one CC suspension device⁸ we noticed a high incidence of secondary displacements. With our current study we wanted to compare the clinical and radiological outcomes of unstable ACJ injuries managed with an acute anatomic synthetic reconstruction of the CC ligaments versus unstable ACJ injuries managed by means of a chronic CC ligaments reconstructions with tendon allograft plus a CC suspension device. We consider it is fundamental to guarantee the primary mechanical stabilization of the chronic reconstruction, which at the end represents the protection of the integration-to-bone period of the reconstructed structures.

It has been also shown that partial loss of vertical reduction do not influence the overall result.² A possible explanation for this finding could be the fact that the healed CC elongated ligaments provide enough stability to relieve symptoms.²⁷ The failure rate after fixation in the chronic setting using only tendon graft has been described to be around 50% or more^{28,29}; while the failure rate after management in the acute setting has been described to be around 26.8%.²⁸ In our study, there were no significant differences between groups. We believe that this issue relies on the fact that we added a primary mechanical stabilizer to the reconstructions performed in the chronic setting.

In the series of 17 patients described by Carofino and Mazzocca, in which the CC ligaments were reconstructed using a semitendinosus allograft passed beneath the coracoid and through bone tunnels in the clavicle, there was a failure rate of 17.65% (3/17).³⁰ One of those patients had a failure due to loss of reduction. We believe that making a tunnel in the coracoid and thus promoting integration-to-bone of the tendon allograft, and incorporating a suspension device; minimizes the probabilities of late elongation of the tendon allograft with subsequent lost of ACJ reduction.

It has been reported that infection rates are higher in the chronic setting than in the acute setting.^{1,3} This issue may be due to the fact that in the chronic setting, surgical times may be longer, tendon allografts are used and surgical approaches are usually wider. In the acute setting, no deep surgical wounds infections have been described.²⁸ A systematic review of the literature describes that the overall rate of superficial infections is around 3.8% for arthroscopic procedures,²⁸ in contrast to a rate of up to 5% for procedures performed by means of open surgery²⁸; and up to 8% in those procedures in which a tendon graft was used.^{31,32} In the series of 17 patients described by Carofino and Mazzocca, one of the patients developed a chronic infection, requiring removal of

the allograft and a latissimus flap for soft tissue coverage.³⁰ In our series, no superficial or deep infections were registered. When compared to the rate of infections reported in the literature, it is possible that differences may be in relation to the low number of patients of our series.

We believe that if it is accepted that in the acute phase the native ligaments have potential to heal and to recover their biomechanical functions, surgeons must take advantage of this situation and save the incorporation of a biological augmentation, which sometimes increases the cost of the procedure (in case of allografts) or the morbidity (in case of autografts).

Considering these premises, with this study we wanted to provide evidences about the management in the acute setting with a procedure that pretends to guarantee mechanical stability and biological restoration (anatomically placed CC suspension devices and healed native CC ligaments), and about the management in the chronic setting with a procedure that also pretends to guarantee mechanical stability and biological restoration (conoid suspension device and anatomic CC reconstruction with tendon allograft).

Our hypothesis established that respecting mechanical and biological premises, the final outcomes might be comparable independently of the timing for surgery. This hypothesis was confirmed.

The main limitations of our study are its retrospective design and the low number of patients. There was not randomization before undergoing one treatment or the other and there was not a previous estimation of the population. The age range is wide. Many of the patients managed in the chronic setting were those that initially rejected the surgical management in the acute setting. Information about the presence or absence of preoperative scapular dyskinesis in the CHRONIC-group was not available. For the purposes of this study, clinical assessments through questionnaires were performed only once. This data collection was performed prospectively (patients were contacted and called to participate in the study, after the hypothesis was formulated).

Considering the mentioned limitations, and therefore despite the limited scope of the study, it might be taken into account that may be not all patients with unstable ACJ injuries should be encourage to have early surgery. In the process of decision-making, patients should be informed that early and late anatomic reconstructions may offer comparable outcomes, but if initial conservative measures are considered and fail, the time “invested” to have a painless and functional shoulder might finally be longer.

6. Conclusion

Patients with unstable ACJ injuries managed by means of an arthroscopy-assisted anatomic CC reconstruction performed in the acute or chronic setting show excellent clinical and radiological outcomes. Management in the acute or chronic setting may involve comparable outcomes if biological and mechanical aspects are considered.

Disclosures

Dr. Juan Sarasquete receives royalties from Biomet® Sports Medicine.

Conflicts of interest

The authors have none to declare.

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