Original article

Acute high-grade acromioclavicular joint injuries treatment: Arthroscopic non-rigid coracoclavicular fixation provides better quality of life outcomes than hook plate ORIF

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A B S T R A C T

Introduction: Treatment of acute high-grade acromioclavicular joint (ACJ) injuries with metal hardware alters the biomechanics of the ACJ, implying a second surgery for hardware removal. The period during which the plate is present involves functional limitations, pain and a risk factor for the development of hardware-related-injuries. Arthroscopy-assisted procedures compared to open-metal hardware techniques offer: less morbidity, the possibility to treat associated lesions and no need for a second operation. The aim was to compare the Quality of life (QoL) of patients with acute high-grade ACJ injuries (Rockwood grade III–V), managed arthroscopically with a non-rigid coracoclavicular (CC) fixation versus the QoL of patients managed with a hook plate, 24 months or more after their shoulder injury.

Patients and methods: A retrospective revision of high-grade ACJ injuries managed in three institutions was performed. Patients treated by means of an arthroscopy-assisted CC fixation or by means of a hook plate were included. The inclusion period was between 2008 and 2012. The QoL was evaluated at the last follow-up visit by means of the SF36, the visual analog scale (VAS), the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, the Constant score and the global satisfaction (scale from 0 to 10). The presence of scapular dyskinesis and remaining vertical instability were evaluated. Comparison groups were performed.

Results: Thirty-one patients were included: 20 arthroscopy-group (ARTH group: 3 Rockwood III, 3 IV and 14 V) and 11 hook plate-group (HOOK group: 5 Rockwood III and 6 V). The mean age was 36 [25–52] year-old for the ARTH group and 41 [19–55] for the HOOK group (P=0.185). The mean results of the questionnaires were: (1) physical SF36 score (ARTH group 58.24 ± 2.16 and HOOK group 53.70 ± 4.33, P<0.001); (2) mental SF36 score (ARTH group 56.15 ± 2.21 and HOOK group 53.06 ± 6.10, P=0.049); (3) VAS (ARTH group 0.40 ± 0.50 and HOOK group 1.45 ± 1.51, P=0.007); (4) DASH (ARTH group 2.98 ± 2.03 and HOOK group 4.79 ± 5.60, P=0.200); (5) Constant score (ARTH group 95.30 ± 2.45 and HOOK group 91.36 ± 6.84, P=0.026); (6) global satisfaction (ARTH group 8.85 ± 0.93 and HOOK group 8.00 ± 1.18, P=0.035). There was evidence of scapular dyskinesis in 15% (3/20) of the patients of the ARTH group and in 18% (2/11) of the patients of the HOOK group (P=1.000). Remaining vertical ACJ instability was observed in 40% (8/20) of the patients of the ARTH group and in 36.36% (4/11) of the patients of the HOOK group (P=1.000).

Conclusion: Patients with acute high-grade ACJ injuries managed arthroscopically with a non-rigid CC fixation seem to have a better QoL than patients managed with a hook plate.

Level of evidence: Level IV therapeutic; retrospective comparative study.

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1. Introduction

Surgical management of acute high-grade acromioclavicular joint (ACJ) injuries should be focused on facing the torn ends of the ligaments, because it is accepted that in the acute phase they still have healing potential [1].

Most methods of treatment incorporate the use of metal hardware, which could alter the biomechanics of the ACJ, thus implying a second surgical procedure for hardware removal once the ligaments have healed [2]. The hook plate, the ACJ transfixion with K-wires (Phemister technique) and the coracoclavicular (CC) fixation with a screw (Bosworth technique) are recognized as non-anatomic procedures related to high rates of fixation failures and complications [3]. Likewise, clinical outcomes depend on the technique performed [4].

Patients with unstable ACJ injuries managed with the hook plate system have shown good and excellent clinical outcomes [5]. On the other side, hook plates must be removed 8 to 12 weeks after surgery, situation that supposes the need of a second surgery. Likewise, it has been widely reported that the period while the plate is implanted involves important functional limitations and great pain for the patients [6]. This implant should be removed before allowing overhead shoulder activities, and motion restriction should be emphasized until removal [7]. Orthopaedic surgeon’s main concern is that hook plates may cause subacromial impingement and even rotator cuff tears [8]. These implant-related adverse effects might influence patient’s final functional outcome [9].

Patients with unstable ACJ injuries managed with arthroscopy-assisted procedures have shown good and excellent clinical outcomes, without the need for a second operation [5]. These procedures incorporate a CC suspension device aimed to narrow the CC space thus allowing the facing of the torn CC ligaments. The advantages that arthroscopy can offer among open techniques are: less morbidity, the possibility of diagnose and treat associated lesions [10]; and the possibility of having a straight visualization of the inferior aspect of the base of the coracoid, convenient when placing CC fixation systems.

It has been postulated that persistent shoulder pain after ACJ surgery could be related to untreated overlooked intraarticular concomitant injuries [11]. Although, this idea seems to be logical, the relation between variables has not been yet studied. The main aim of this study was to compare the QoL of patients with acute high-grade ACJ injuries managed arthroscopically with an early non-rigid CC fixation versus the QoL of patients managed with a hook plate, 24 months or more after shoulder injury. The secondary aim was to arthroscopically assess the prevalence of concomitant intraarticular injuries in the ARTH group.

We hypothesized that patients with acute high-grade ACJ injuries managed arthroscopically with an early non-rigid CC fixation have a better QoL than patients managed with a hook plate.

2. Patients and methods

2.1. Study design

A retrospective cohort study was performed in three tertiary hospitals. Patients, diagnosed of high-grade ACJ injuries (grade III–V according to the Rockwood classification) and managed operatively by means of an arthroscopy-assisted non-rigid CC fixation or by means of open reduction and internal fixation with a hook plate, were included.

All patients gave their written informed consent and accepted that data from their electronic medical files could be used for purposes of this scientific research.

2.2. Study population

Most of the study population was obtained from records registered for a previous study [12] in which the electronic medical files of two institutions were reviewed. For the purposes of this study, authors invited to participate the trauma unit of a third institution, in order to increase the number of cases and to provide comparative evidences between different treatment methods and surgical strategies.

All the records of the shoulder and trauma clinics of these three institutions coded as “ACJ injuries” between January 1st 2008 and January 31st 2012 were revised. Patients were included in the study following these inclusion criteria:

- either sex;
- radiographic diagnose of high-grade ACJ injury;
- physically active and between 18 and 55 year-old at the moment of acute injury;
- managed operatively by means of an arthroscopy-assisted non-rigid CC fixation (ARTH group) or by means of open reduction and internal fixation with a hook plate (HOOK group);
- with a clinical history and radiological examination complete and available at the moment of the revision of the records;
- with a minimum follow-up of 24 months after surgery;
- operated within the first three weeks after shoulder injury.

The exclusion criteria were:

- radiographic diagnose of an ACJ injury Rockwood grade I–II;
- surgical treatment performed three weeks after ACJ injury (because it has been described that after this period the CC ligaments lack of healing potential [13]);
- previous injuries to the respective shoulder;
- surgical techniques other than acute arthroscopically assisted CC non-rigid fixation, or fixation with a hook plate.

The patients who fulfilled these eligibility criteria were contacted and proposed to be included in the study.

Once patients were contacted and accepted to participate in the study, they signed an informed consent (“last follow-up visit”), and radiographic and clinical examinations of the injured shoulder were collected.

2.3. Quality of Life (QoL) evaluations

The QoL was assessed by means of:

- the SF36: (1) physical and (2) mental;
- the VAS of the injured shoulder: “0” corresponding to “no pain” and “10” corresponding to “the worst pain imaginable”
- the DASH questionnaire;
- the Constant score;
- the “Global Satisfaction” scale (numerical rating scale from 0 to 10; being 0, not satisfied with the treatment, and 10, completely satisfied with the results of the treatment).

Items of the Constant score (range of motion, strength and activity limitations) are also presented separately. In order to be able to make dichotomous differences between groups; when drawing back items about limitations, “severe” and “moderate” limitations were grouped into only one category (“yes”). However, for the purposes of calculating the Constant score itself, these items were considered as described by the authors [14] (for example, sport limitation: severe, moderate, no).
2.4. ACJ injury classification

Classification was made by means of observing the X-rays performed at the initial visit post-injury. Clinical examination in the acute setting was not considered for classification. Radiographic examinations of both shoulders were performed to all patients at the initial visit post-injury. The X-rays protocol of these three institutions included: strict anteroposterior (AP) view (both shoulders), Zanca view (both shoulders) and axillary view (only injured shoulder). The cross-body adduction view (Alexander view) was performed at the initial visit post-injury in two of the three institutions, so in accordance to the diversification of the Rockwood classification proposed by ISAKOS [15], the classification could not be updated as it was done in a previous study [12]. In the three institutions, axillary views were performed with the patient in the prone position, and necessary abduction of the shoulder was passively achieved through manipulation by the examiner.

Grade III and grade V injuries were differentiated according to the traditional Rockwood classification [16]. A grade III if the CC distance of the injured shoulder was increased between 25–100% when compared to the non-injured shoulder; and a grade V if the CC distance of the injured shoulder was increased between 100–300% when compared to the non-injured shoulder [16]. 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 [16].

2.5. Treatment decision-making

The consultant in charge at each of the three institutions lead the decision-making. There was not randomization before decision-making.

In regards to the severity of the injuries, decision-making was based on the radiologic 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 deltotrapezial fascia [2,17], which also plays a determinant role in the stability of the ACJ [18].

Patients with acute high-grade ACJ injuries Rockwood grade IV–V were told that there were international recommendations regarding the surgical management for this type of injuries [2]; 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.

Once the diagnosis high-grade ACJ injury was established, patients were informed about the different treatment options. Specifically, patients of the HOOK group were told that the plate had to be removed 12 to 16 weeks after implantation.

Likewise, patients of the ARTH group were told about the risks of a surgical intervention and about the possibility of diagnose and treat concomitant glenohumeral injuries.

2.6. Management: arthroscopically assisted non-rigid CC fixation and hook plate

2.6.1. ARTH group

This technique has been previously described [12]. Patients were placed in the beach chair position under general anesthesia and interscalene block. The arm was fixed to a mechanical arm holder with the shoulder elevated up to 45–50° and with 2–3 kg of traction. Three standard arthroscopic portals were used: posterior, anterolateral and lateral. Diagnostic arthroscopic examination of the shoulder was performed in order to detect glenohumeral concomitant injuries. With the arthroscope placed in the lateral portal, subacromial bursa debridement was performed through the anterolateral portal in order to visualize the coracoclavicular (CA) ligament. This structure was then followed to the coracoid base. The base of the coracoid undersurface was debrided. A 3-cm incision perpendicular to the clavicle was made, then the tip of the acromioclavicular guide was placed at the bottom of the base of the coracoid under arthroscopic visualization, near the wall of the scapula; and the sliding tube of the guide was located on top of the clavicle with an angle of 80–90° at the middle of what it should be the native origins of the CC ligaments (isometric reconstruction), placing the suspension device 3-cm medial to the lateral edge of the clavicle [12,19]. A 2.4-mm K-wire was passed from the clavicle to the coracoid and the isometric tunnel was made over the K-wire with a 4.5-mm cannulated drill. A shuttle-suture was then retrieved from the coracoid tunnel and then the CC suspension device (TightRope, Arthrex, Inc, Naples, Florida, USA) was introduced from the coracoid to the clavicle, guided by the suture. The titanium flip was placed at the base of the coracoid process and the button at the top of the clavicle. The ACJ was manually reduced by pushing the elbow upwards and the clavicle downwards at the same time. The traction sutures of the system were alternatively pulled until the clavicle washer of the system locked. Anatomic reduction was confirmed by means of direct visualization and palpation. Closure of the deltotrapezoidal fascia was then performed to secure the reduction. The skin was sutured and the arm was placed in a sling.

2.6.2. HOOK group

Fluoroscopy was positioned at the head of the bed. A standard anterior approach to the clavicle was performed. The ACJ injury was exposed and reduced under direct visualization. Hook plates (Synthes, West Chester, USA) were used in all patients. The soft tissue dorsal to the ACJ was dissected and prepared for the insertion of the hook. Detachment of the extracapsular fibers of the trapezius from the medial border of the acromion was performed. The hook was passed below the acromion and the plate was applied. Plates were then secured to the clavicle shaft with four or five 3.5 mm cortical screws, approximating the plate to the clavicle. Proper reduction and fixation was checked with fluoroscopy. The deltotrapezial fascia was carefully sutured in order to guarantee an appropriated coverage of the plate. The skin was closed with staples in all cases.

2.7. Rehabilitation protocol

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. Patients of the HOOK group were allowed to passively move the shoulder no more than 90° of elevation in the plane of the scapula after the first week, and patients of the ARTH group three weeks after surgery. Pendulum exercises begin from the first week post-injury in both groups.

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 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 by one of the investigators, based on the X-rays performed at the last follow-up visit. Remaining vertical ACJ instability was evaluated. For the purposes of this study, in the HOOK group these assessments were performed once the implant was removed. Remaining vertical ACJ
instability was assessed on bilateral Zanca views. In both groups, the maintenance of ACJ post-surgical reduction and the development of post-surgical secondary displacement were radiologically evaluated according to the modified Rosenørn and Pedersen classification [20]. 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.

2.9. Registration of adverse events related to treatment 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 scapulothoracic movements [21].

The presence of scapular dyskinesis was assessed at the last follow-up visit by one of the investigators, by means of the “yes/no” method described by Kibler’s group [22]. 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.

3. Statistical analysis

The sample was formed by all of the patients of the study period who fulfilled the inclusion criteria. 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 Chi² test or Fisher’s exact test depending on what corresponded. The t-test was applied to analyze quantitative variables. 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% (α = 0.05). Data were analyzed by use of the SPSS 19 (SPSS Inc., Chicago, Illinois).

4. Results

4.1. Population characteristics

A total of 31 out of 120 screened patients were included: 20 ARTH group (3 Rockwood III, 3 IV and 14 V) and 11 HOOK group (5 Rockwood III and 6 V). The proportion of cases with injury of the deltotrapezial fascia was 85% [(17/20), 3 grade IV and 14 grade V] in the ARTH group and 54.55% [(5/11), 6 grade V] in the HOOK group (P = 0.038). Fig. 1 shows the flowchart for enrollment of the patients. Table 1 shows the baseline characteristics of the study population by treatments groups. The mean age was 36 [range 25–52] year-old for the ARTH group and 41 [19–55] for the HOOK group (P = 0.185). There were 17 men in the ARTH group and 11 in the HOOK group. The mean follow-up was 38.40 ± 4.34 months for the ARTH group and 32.50 ± 11.64 months for the HOOK group (P = 0.052). The mean [range] time from acute ACJ injury until the last follow-up visit for both groups was 36 [24–78] months. The mean time elapsed from

![Fig. 1. Flowchart for enrollment of the cases according to the criteria established in the study protocol.](image-url)
implantation of the hook plate until its removal was 3.98 ± 1.71 months.

In the ARTH group (Fig. 2A), concomitant glenohumeral injuries were detected and treated in 20% (4/20) of the patients: 1 posterior Bankart, 2 slap lesions type II and 1 rotator cuff tear. These injuries were catalogued to be acute, thus were managed by means of fixation with suture-anchors. In the HOOK group, it was not possible to assess the glenohumeral joint in order to diagnose concomitant injuries.

4.2. Quality of life evaluations

These results are presented in Table 2.

Table 2
Quality of life results.

<table>
<thead>
<tr>
<th>Quality of life evaluations</th>
<th>ARTH group (n=20)</th>
<th>HOOK group (n=11)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF36 for physical domain</td>
<td>58.24 ± 2.16</td>
<td>53.70 ± 4.33</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SF36 for mental domain</td>
<td>56.15 ± 2.21</td>
<td>53.06 ± 6.10</td>
<td>0.049</td>
</tr>
<tr>
<td>VAS for pain</td>
<td>0.40 ± 0.50</td>
<td>1.45 ± 1.51</td>
<td>0.007</td>
</tr>
<tr>
<td>DASH questionnaire</td>
<td>2.98 ± 2.03</td>
<td>4.79 ± 5.60</td>
<td>0.200</td>
</tr>
<tr>
<td>Constant score</td>
<td>95.30 ± 2.45</td>
<td>91.36 ± 6.84</td>
<td>0.026</td>
</tr>
<tr>
<td>Global satisfaction</td>
<td>8.85 ± 0.93</td>
<td>8.00 ± 1.18</td>
<td>0.035</td>
</tr>
</tbody>
</table>

4.3. Radiographic follow-up

Remaining vertical instability was registered in 38.70% (12/31) of the patients (Fig. 2B). In the ARTH group, anatomic reduction of the ACJ was finally achieved in 60% (12/20) of the patients; subluxations were observed in 20% (4/20); and complete dislocations were observed in 20% (4/20).

In the HOOK group (Fig. 3A), anatomic reduction of the ACJ was finally achieved in 63.63% (7/11) of the patients; subluxations were observed in 18.18% (2/11) (Fig. 3B); and complete dislocations were observed in 18.18% (2/11).

In summary, the proportion of patients with remaining vertical instability at the last follow-up visit was 40% (8/20) in the ARTH group and 36.36% (4/11) in the HOOK group (P=1.000). These results are presented in Table 5.

4.4. Adverse events related to treatment and complications

One of the patients of the HOOK group had a persistent severe pain several months after plate removal, so a MRI was performed. The short inversion time inversion recovery (STIR)
Table 4
Sleep, daily living and sports limitations.

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 31)</th>
<th>ARTH group (n = 20)</th>
<th>HOOK group (n = 11)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sleep affected (yes)</strong></td>
<td>6 (19.35)</td>
<td>1 (5)</td>
<td>5 (45.45)</td>
<td>0.013</td>
</tr>
<tr>
<td><strong>Daily living limitation (yes)</strong></td>
<td>7 (22.58)</td>
<td>3 (15)</td>
<td>4 (36.36)</td>
<td>0.209</td>
</tr>
<tr>
<td><strong>Sports limitation (yes)</strong></td>
<td>8 (25.80)</td>
<td>2 (10)</td>
<td>6 (54.55)</td>
<td>0.012</td>
</tr>
</tbody>
</table>

![Fig. 3. A. X-ray in AP view of a right shoulder, showing the fixation of a high-grade ACJ injury by means of a hook plate. B. X-ray in AP view of a both shoulders performed 15 days after plate removal. Vertical subluxation of the ACJ can be observed.](image)

Table 5
Scapular dyskinesis and remaining vertical instability assessed at the last follow-up visit.

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 31)</th>
<th>ARTH group (n = 20)</th>
<th>HOOK group (n = 11)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scapular dyskinesis</strong></td>
<td>5 (16.12)</td>
<td>3 (15)</td>
<td>2 (18.18)</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>Remaining vertical instability</strong></td>
<td>12 (38.70)</td>
<td>8 (40)</td>
<td>4 (36.36)</td>
<td>1.000</td>
</tr>
</tbody>
</table>

![Fig. 4. A. Coronal reconstruction of a MRI in STIR sequence performed to one of the patients of the HOOK group that was having persistent severe pain several months after plate removal. Observe the important acromial bone edema caused by the persistent pressure of the hook. B. X-ray in AP showing a right shoulder with a high-grade ACJ injury that was managed with a CC suspension device in which implant failure was observed. The subcoracoid flip lost its fixation. C and D. Posterior perspective of patients while performing shoulders forward flexion. Observe the prominence of the inferomedial border of the scapula (white arrows).](image)

sequence revealed an important subacromial bone edema (Fig. 4A). This situation was managed by means of a corticoid injection, and the symptoms subsided.

In the ARTH group, there were 3 complications related to surgery: 1 implant failure (Fig. 4B) that required a re-intervention managed with another CC suspension device and a semitendinous allograft, according to our previously described technique [17]; and 2 surgical wound granulomas.

In the HOOK group there were 2 complications related to surgery: 1 surgical site infection that required a surgical debridement and the breakage of a screw that could not be removed from the clavicle.
At the last follow-up visit, there was evidence of scapular dyskinesis in 15% (3/20) of the patients of the ARTH group and in 18.18% (2/11) of the patients of the HOOK group ($P = 1.000$) (Fig. 4C and D). These results are presented in Table 5.

5. Discussion

The main finding of this study was that patients with acute high-grade ACJ injuries managed arthroscopically with a non-rigid CC fixation have a better quality of life in terms of the SF36 (physical and mental), the VAS, the Constant score and the global satisfaction, than patients managed with a hook plate.

In regards to the surgical approach of high-grade ACJ injuries, the literature is plenty of surgical procedures. It has been reported that the CA ligament transfer, the hook plate fixation, the AC K-wire fixation and the CC screw fixation could be considered as biomechanically insufficient [23]. In vivo analysis of ACJ motion after hook plate fixation has shown that the clavicular motion and the ACJ biomechanics changed significantly [24]. The technique chosen may have a strong influence on the result, especially if open procedures and fixation with metal hardware are performed.

In our study, patients of the HOOK group rated their questionnaires worst than those of the ARTH group. When patients of the HOOK group were asked about their global satisfaction in regards to the outcomes, many of them referred to the discomfort they felt during the time the hook plate was implanted, information that coincide with previous publications [6]. We believe that the functional limitation and pain patients perceive while the hook plate is implanted has a determinant influence over the self-perception of the result. Bosström et al. described that patients managed with a hook plate had significantly more pain than patients managed by means of a CC non-rigid fixation [25]. They argue that it may be due to the presence of a chronic irritation in the subacromial space, which leads to a persistent pain syndrome [25].

In this study, patients of the ARTH group had a better Constant score at the last follow-up visit than patients of the HOOK group. Likewise, Items of the Constant score were broken down. No differences were encountered in regards to the range of motion, the strength nor the daily living limitations. However, statistically significant differences were encountered regarding the sleep, the sports limitations and the pain. Differences in these items were determinants to “make a difference” when summarizing the whole Constant score. On the other side, no statistically significant differences were found in regards to the DASH score. We believe that this issue may be due to the fact that the DASH score involves more subjective items to assess than the Constant score, situation that may lead to dissolution of the possible differences. Items of the Constant score are more objective and focused on the physical examination, while all thirty items of the DASH score are merely subjective. Taking in consideration that in both groups of our series the objective items were “comparable”, and taking in consideration that the Constant score involves only two subjective items (pain and activity level: sleep, daily living and sports), differences between groups in regards to these subjective items made the overall Constant score of the ARTH group higher enough to reach a significant difference.

The results of our study coincide with those published by Andreani et al., in which their group of patients managed with the Tightrope® system had a mean Constant score of 90, and the group of patients managed with a hook plate had 75 [26]. On the other side, in the study published by Jensen et al., patients managed with the hook plate system or arthroscopically with a CC suspension device showed equally good and excellent clinical results [5]. Despite there were not significant differences, their group of patients managed by means of the hook plate showed a mean VAS of 0.8, while the group of patients managed by means of the Tightrope® showed a mean VAS of 0.4 [5].

In regards to the hook plate, open reduction and ACJ fixation with this system can be an extensive surgical procedure. Part of the hook gets in the posterior aspect of the AC ligaments, and this might represent a reason that compromises the proper healing of these structures. Likewise, hook plates must be mandatory removed, and the period while the plate is implanted might involve the development of serious complications, such as cutting upward of the hook through the acromion [27], acromial osteolysis [28] and fracture [29], ACJ osteoarthritis, subacromial impingement, rotator cuff tears [30] and plate bending [31]. Despite timely removal of the plate, it could be also an increased risk of fracture of the distal clavicle after low energy trauma [32].

Lin et al. described that in a group of patients with ACJ injuries and distal third clavicle fractures managed by means of the hook plate, 37.5% (15/40) developed subacromial impingement syndrome, and their functional scores were poorer than the non-impinged patients [9]. Among these patients, 40% (6/15) had a rotator cuff tear diagnosed by means of a sonographic evaluation. Likewise, acromial erosion caused by hook pressure was observed in 50% (20/40) of the patients. All patients of this series had their plates removed at a mean time of 5.78 months [9]. In our series, the mean time elapsed from plate implantation to removal was 3.98 months. We did not perform sonographic evaluation of our patients, but we consider that the lower scores registered in the questionnaires could rely on possible underlying injuries related to the plate.

In regards to remaining vertical instability, biomechanical studies have shown that the hook plate involves a biomechanical disadvantage when compared to CC non-rigid fixations. The CC displacement during cyclic loading has been shown to be higher for hook plate fixations [33]. Despite these biomechanical premises, clinical studies comparing patients managed with the hook plate versus patients managed with CC non-rigid fixations have shown no differences in regards to the remaining vertical instability [5]. It has been also shown that partial loss of vertical reduction do not influence the overall result [13]. A possible explanation for this finding could be the fact that the healed CC elongated ligaments provide enough stability to relieve symptoms [26].

In regards to the shoulder biomechanics, it has been shown that some of the patients with high-grade ACJ injuries might develop scapular dyskinesis, situation that could result in loss of strength, pain and weakness [2]. Likewise, it has been shown that the prevalence of scapular dyskinesis in those patients that have been managed operatively [34] is lesser when compared to patients managed non-operatively [35]. The described prevalence of scapular dyskinesis in patients managed operatively is 11.7% [34]. In our study, there were no differences between groups in regards to the prevalence of scapular dyskinesis. Our results partially coincide with those previously published. Our overall prevalence of scapular dyskinesis was 16.1% (5/31): 15% (3/20) in the ARTH group and 18.8% (2/11) in the HOOK group.

Diagnosis and treatment of concomitant glenohumeral injuries and no mandatory implant removal are the advantages of a CC non-rigid fixation arthroscopically-assisted [5]. Likewise, it has been postulated that possible remaining concomitant intraarticular injuries may represent the reasons for failure of some of the cases managed by means of open surgery without access to the glenohumeral joint or by means of non-operative management [5]. We are now defending the idea that, if orthopaedic surgeons decide to manage acute unstable ACJ injuries by means of an open procedure that does not involve access to the glenohumeral joint, it should be considered to perform a preoperative MRI arthrography to avoid “leaving behind” important simultaneous acute injuries that, in case they go unnoticed, may significantly condition the final outcome.

In regards to synthetic ligament reconstructions in acute ACJ injuries, the synthetic graft most commonly known is the Ligastic®
Cohen et al. described a 19% (3/16) rate of partial loss of reduction in a series of patients managed by means of a synthetic ligament placed arthroscopically between the clavicle and the coracoid, and with a mean follow-up of 12 months [37]. The rate of loss of reduction observed in the ARTH group of our series was 40% (8/20), with a mean follow-up of 32.5 months. In regards to the development of secondary displacements, differences between these series of patients might be in relation to the mean follow-up (12 months in the series of Cohen versus 32.5 months in the ARTH group of our series). We believe that, when using only one CC suspension device, it is matter of time until an ACJ subluxation may be developed. Although it seems that clinical outcomes are not affected by this issue [26], we are actually making anatomic synthetic reconstructions with two CC suspension devices plus an AC augmentation with an all suture anchor plus a careful reconstruction of the deltotorpezial fascia, which plays a determinant role in the vertical and horizontal stabilization of the ACJ [18].

Despite all the evidence today available about the biomechanical and biological disadvantages that might arise from the fixation with a hook plate, in both groups of our series high scores were registered at the questionnaires performed at the last follow-up visit. Although significant differences were found when final outcomes were compared, we assume that the clinical relevance of these statistical differences may be questioned by trauma-surgeons that are used to this “easy to place” implant.

The main limitation of our study is its retrospective design. Patients were not randomized before undergoing one treatment or the other. The number of patients is low. The ARTH group was managed by only one shoulder surgeon, and the HOOK group was managed by many trauma-surgeons. The age range is wide, and the mean age of the HOOK group patients is higher, although this difference was not significant. The proportion of cases with injury of the deltotorpezial fascia was significantly higher in the ARTH group; but nevertheless, better clinical outcomes were obtained at the last follow-up assessment of this group.

Taking in account that MRIs were not performed preoperatively, we were only able to assess the prevalence of simultaneous intraarticular injuries in the group managed by means of the arthroscopy-assisted procedure. Likewise, MRI study was not performed postoperatively to all patients of the HOOK group.

For the purposes of this study, clinical assessments through questionnaires were performed only once.

It must be mentioned that there is scarce information regarding surgical outcomes of ACJ injuries if the lesions are broken down into types III through V according to the classification of Rockwood [38]. Most reports include type III ACJ injuries [20,27,39,40]. This study adds evidence to the few studies actually available [5].

6. Conclusion

In this study, patients with acute high-grade ACJ injuries managed arthroscopically with a non-rigid CC fixation had a better quality of life in terms of the SF36 (physical and mental), the VAS, the Constant score and the global satisfaction, than patients managed with a hook plate, 24 months or more after shoulder injury. Lower scores registered in the questionnaires of the HOOK group could rely on possible underlying injuries related to the plate, and higher scores of the ARTH group might be in relation to the management of concomitant intraarticular injuries.

Disclosure of interest
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The other authors declare that they have no competing interest.

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