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Original article

Prognostic factors to succeed in surgical treatment of chronic acromioclavicular dislocations



J. Barth^{a,*}, F. Duparc^b, L. Baverel^a, J. Bahurel^c, B. Toussaint^c, S. Bertiaux^b, P. Clavert^d, O. Gastaud^e, N. Brassart^f, E. Beaudouin^g, P. De Mourgues^h, D. Berneⁱ, M. Duport^j, N. Najihi^k, P. Boyer^l, B. Faivre^m, A. Meyerⁿ, G. Nourissat^o, S. Poulain^p, F. Bruchou^q, J.F. Ménard^r, the Société Française d'Arthroscopie

^a Centre ostéo-articulaire des Cèdres, parc Sud Galaxie, 5, rue des Tropiques, 38130 Échirolles, France

^b CHU de Rouen, 76000 Rouen, France

^c Clinique générale, 74000 Annecy, France

^d Service de chirurgie de l'épaule et du coude, CCOM, CHRU de Strasbourg, 67000 Strasbourg, France

^e Hôpital Pasteur 2, institut universitaire de l'appareil locomoteur et du sport, CHU de Nice, 30, voie Romaine, CS51069, 06001 Nice cedex 1, France

^f Clinique de Cagne-sur-Mer, 06800 Cagne-sur-Mer, France

^g Centre hospitalier régional de Chambéry, 73000 Chambéry, France

^h Médipôle de Savoie, 73000 Chambéry, France

ⁱ Clinique Kennedy, 26200 Montélimar, France

^j Médipôle Garonne, 31000 Toulouse, France

^k CHU de Rennes, 35000 Rennes, France

^l Hôpital universitaire Xavier-Bichat, 75018 Paris, France

^m Hôpital universitaire Ambroise-Paré, 92100 Boulogne-Billancourt, France

ⁿ CMC Paris V, 75005 Paris, France

^o Chirurgie de l'épaule Groupe Maussins, 67, rue de Romainville, 75019 Paris, France

^p Polyclinique du Plateau, 21, rue de Sartrouville, 95870 Bezons, France

^q Hôpital privé de l'Ouest Parisien, 78190 Trappes, France

^r Unité biostatistique du CHU de Rouen, Rouen, France

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ABSTRACT

Introduction: Treatment of chronic acromioclavicular joint dislocation (ACJD) remains a poorly known and controversial subject. Given the many surgical options, it is not always easy to determine which steps are indispensable.

Methods: This article reports a multicenter prospective study. The clinical and radiological follow-up involved a comparative analysis of the preoperative and postoperative data at 1 year, including pain (visual analogue scale), subjective functional incapacity (QuickDASH), and the objective Constant score, as well as a comparative analysis of vertical and horizontal movements measured on simple x-rays.

Results: Based on a series of 140 operated ACJDs, we included 24 chronic ACJDs. The mean time to surgery was 46 weeks (range, 1 month to 4 years). The patients' mean age was 41 years, with a majority of males (75%), 72% of whom participated in recreational sports. Professionally, 40% of the subjects had jobs involving manual labor. We noted 40% grade III, 24% grade IV, and 36% grade V injury according to the Rockwood classification. In 92% of cases, coracoclavicular stabilization was provided by a double button implant, reinforced with a biological graft in 88% of the cases. In 29%, millimeters to centimeters of the distal clavicle were resected and acromioclavicular stabilization was associated in 54%. We observed complications in 33% of the cases. At 1 year postoperative, 21 patients underwent clinical and radiological follow-up (87.5%). Only 35% of the patients were satisfied or very satisfied, whereas 100% of them would recommend the operation. Full-time work was resumed in 91% of the cases and all sports could be resumed in 86%. The pre- and postoperative values at 1 year changed as follows: the mean Constant score improved from 61 to 87 ($p=0.00002$); the subjective QuickDASH score decreased from 41 to 9 ($p=0.00002$); and radiologically significant reduction of the initial displacement was observed in the vertical plane ($p < 10^{-3}$) and the horizontal plane ($p=0.022$).

* Corresponding author.

E-mail address: jrthbarth@yahoo.fr (J. Barth).

Conclusion: In this study, the favorable prognostic factors found were: time to surgery less than 3 months ($p=0.02$), associated acromioclavicular stabilization, and postoperative immobilization with a sling extended to 6 weeks. However, resection of the distal clavicle did not influence the final result.

Level of proof: Level II prospective non-randomized comparative study.

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1. Introduction

Although ACJDs (acute acromioclavicular joint dislocations) account for a large share of traumatology care, it is much rarer to see patients consulting at the chronic stage. For Warren-Smith and Ward, 15–40% of ACJDs initially treated conservatively evolve toward an unfavorable functional result [1]. These patients complain of residual pain, popping, paresthesia, and loss of strength or fatigability, particularly during physical activities with the arm above the scapular girdle [2]. The definition of chronicity is already a subject of controversy. To our mind, chronicity is an anatomopathological definition related to the resorption and/or progressive retraction of ligaments at a given stage or the impossibility of spontaneous healing of the acromioclavicular and coracoclavicular ligaments [2], which becomes irreversible, despite satisfactory reduction of the dislocation. Most authors consider that the limit is around the 21st day [3], even if at this time it is difficult to know whether spontaneous healing can be favorable (despite persistent deformity) with conservative treatment [4–7]. This is the problem with Rockwood classification grade III injuries, which have not been clearly described in guidelines [8,9]. At what point in time can conservative treatment be considered a failure so as to plan surgical treatment? Should one wait 3 months, 6 months, or 1 year after injury to consider surgery? Does the time between the accident and surgery influence the final result? How do different times to surgery differ in the management of acute cases?

1.1. Objective of the study

The main objective of the study was to analyze the prognostic factors influencing the anatomical and functional results of endoscopically assisted ACJD repairs in which the time from injury to surgery was longer than 21 days.

2. Methods

2.1. Type of study

This was a multicenter prospective study promoted by the French Society of Arthroscopy (SFA [Société Française d'Arthroscopie]). The main investigators were Fabrice Duparc (Rouen) and Johannes Barth (Grenoble). Twenty-two surgeons in 14 centers participated in the study, with the inclusion period lasting 12 months, from July 2012 to July 2013. The clinical and radiological follow-up was carried out until July 2014 so as to obtain preoperative, intraoperative, and postoperative linear controlled progression at 3 months and 1 year.

2.2. Inclusion and exclusion criteria

The inclusion criteria were severe ACJD (grades III, IV, and V) operated after more than 21 days. The exclusion criteria were the presence of a fracture, associated lesions (rotator cuff rupture or labral lesions) or glenohumeral osteoarthritis. The surgical technique was left to the discretion of the surgeon but with at least endoscopically assisted coracoclavicular stabilization

acromioclavicular stabilization was optional, as was the use of biological reinforcement.

The medical files were included anonymously using CALIMED® software (CALIMED, Marseille, France).

2.3. Clinical follow-up

The clinical follow-up included a comparative analysis of the pre- and postoperative data at 1 year: pain was evaluated using a visual analogue scale, unweighted subjective functional incapacity using QuickDASH, and the objective Constant score was calculated.

2.4. Radiological follow-up

The radiological assessment comprised a comparative analysis of vertical and horizontal displacements measured on pre- and postoperative x-rays at 1 year. Postoperatively, the protocol described by Tauber et al. [10] was followed to obtain dynamic radiographs in order to assess persistent horizontal instability defined as a greater than 12° difference between 0° of flexion (neutral position) and 60° of flexion, when measuring the Gleno-Acromio-Clavicular Angle (GACA) on the affected side.

2.5. Statistical analysis

When the CALIMED® portal was closed, the data were extracted into an Excel file. The statistical tests were carried out in the Biostatistics Unit at the Rouen University Hospital by J.F. Ménard. The qualitative variables were analyzed in contingency tables using a Chi² test or a Fisher exact test. Mann-Whitney tests and Kruskal-Wallis tests were used for comparisons. For the quantitative variables, the Spearman correlation was used.

3. Results

3.1. Series

Based on a series of 140 ACJDs treated surgically, we included 116 ACJD patients at the acute stage (operated before 21 days after injury) and 24 chronic ACJD patients (operated after 21 days). The mean time to surgery was 46 weeks (range, 4–208 weeks), with the median at 27 weeks (Fig. 1). The patients' mean age was 41 years (range, 22–64 years), with a majority of males (75%), the mean body mass index (BMI) was less than 25 (range, 19.1–31.6), in 58% of the cases, the lesion involved the dominant limb. We observed no risk factors.

Sports activities: 72% of the patients participated in recreational sports, 24% in contact sports, and 4% of the patients did not take part in any sports. Professionally, 40% of the subjects had jobs involving manual labor, 44% had a sedentary job, 12% were professional athletes, and 4% were retired. In 58% of the cases, the injury involved a sports accident, in 29% a traffic accident, and in 13% a household accident (Figs. 2 and 3).

The injuries were grade III in 40% of the patients, 24% grade IV, and 36% grade V according to the Rockwood classification.

Table 1

Detail of the different surgical techniques used.

Coracoclavicular stabilization [24]	22 Double endo-button (7 Dog Bone®, 7 Graft Rope®, 6 Tight Rope®, 3 Twin Bridge®)	2 Lars® + reverse Waever-Dunn	
Biological graft on AC [2] Biological graft on CC [19]	16 Weaver-Dunn (12 isolated) and 4 combined cases (with a palmaris longus graft) 3 Gracilis or semitendinosus	2 reverse Waever-Dunn	
Acromioclavicular stabilization [15]	11 Overlap sutures	2 fixations with temporary pins	2 Reverse Weaver-Dunn 7 Resections (mm or cm) distal from the clavicle

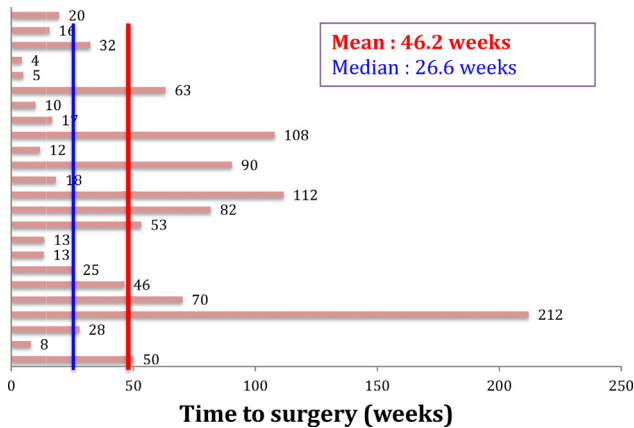


Fig. 1. Time to surgery.

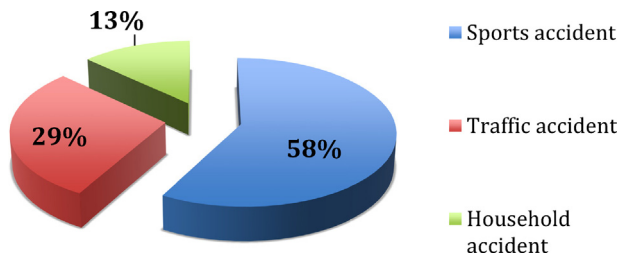


Fig. 2. Distribution by type of accident.

3.2. Surgical technique

The only restriction imposed on the investigators was endoscopic guidance for coracoclavicular stabilization. In 92% of the cases, this was done with a double button coracoclavicular fixation, reinforced by a biological graft in 88% of the cases (coracoacromial, palmaris longus, gracilis, or semitendinosus ligament). When it was used ($n=21$), the biological reinforcement was used in the coracoclavicular space in 19 of the cases and to reinforce the acromioclavicular joint in two cases (with the coracoacromial ligament in a reverse Weaver-Dunn procedure). In the coracoclavicular space, the reconstruction was non-anatomic in 14 cases (60%) using the coracoacromial ligament (Weaver-Dunn procedure + double

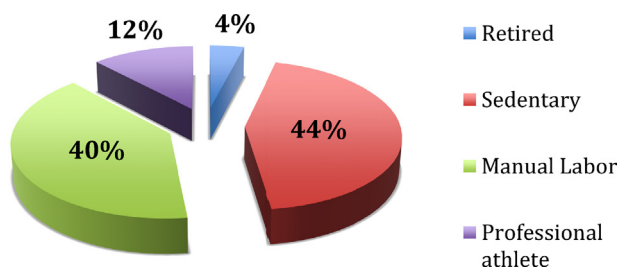


Fig. 3. Distribution by profession.

button), anatomic in four cases (15%) with a free graft (one palmaris longus, three gracilis or semitendinosus), and combined in six cases (25%). In 29%, millimeters or centimeters of the distal clavicle were resected and acromioclavicular stabilization was associated in 54% (11 overlap sutures and two reverse Weaver-Dunn procedures). All the details of the procedures performed are reported in Table 1.

3.3. Postoperative care

Immobilization lasted 21–30 days for 25% of the patients and 31–45 days for 75% of the cases with a sling.

3.4. Complications

We observed complications in 33% of the patients: four benign complications (two cases of algodystrophy and osteolyses with the double button disassembling) and four serious complications: three cases of late device failure and one fracture of the coracoid process. One case of late device failure and fracture of the coracoid process required surgical revision.

3.5. Functional results

At 6 weeks the mean passive anterior elevation was 111°, with the median at 120°; the mean lateral rotation of the shoulder was 50° with a median of 40°. At this time, return to work was possible in 52% of the cases and sports could be resumed in 8%.

At the 1-year postoperative follow-up, 21 patients (87.5%) were seen for clinical and radiological evaluation. Only 35% of the patients were satisfied or very satisfied, whereas 100% of them declared that they would recommend the operation (Fig. 4). Pain assessment (at 3 months and 1 year postoperative) is reported in Fig. 5. Return to work full-time was possible in 91% of the cases (Fig. 6) and return to all sports was possible in 86% at 1 year postoperative (Fig. 7). Three patients (14%) retained a deficit in lateral

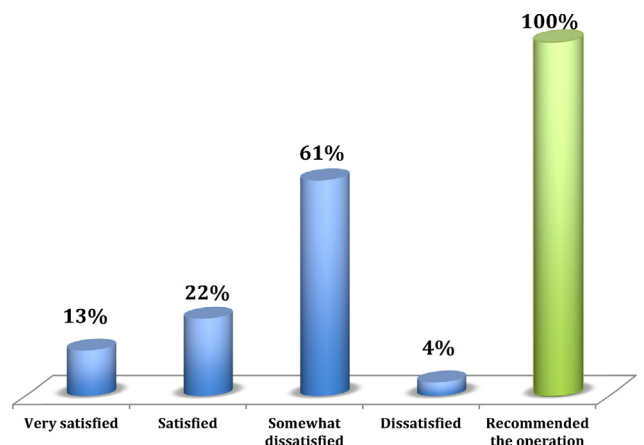


Fig. 4. Satisfaction rate 1 year postoperative.

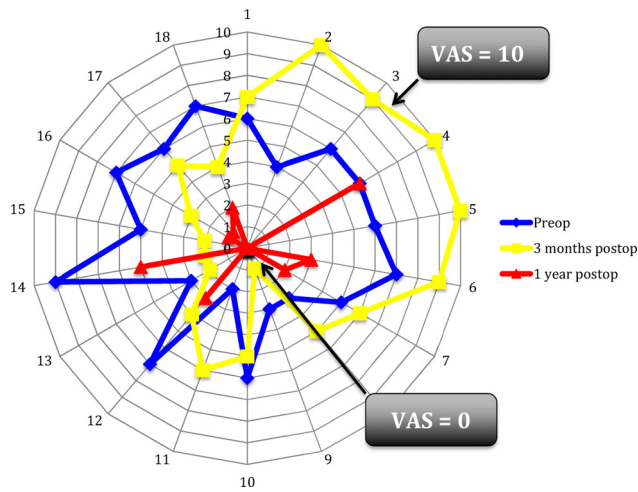


Fig. 5. Evaluation of preoperative pain, then at 3 months and 1 year after surgery.

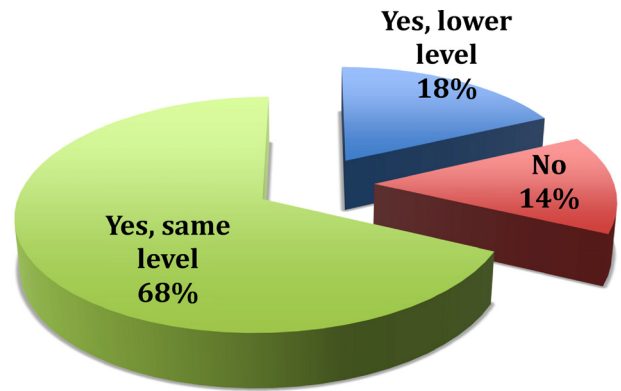


Fig. 7. Return to sports.

score decreased from 41 before surgery to 9 at 1 year after surgery, a statistically significant improvement ($p=0.00002$) (Fig. 9).

3.6. Radiological results

The analysis in the vertical plane on the AP acromioclavicular joint view and the calculation of the ratio of the coracoclavicular distance of the injured versus the healthy side (Fig. 10) showed a significant gain between the preoperative values (mean, 216%) and 1-year postoperative values (mean, 158%) ($p < 10^{-3}$).

The analysis in the horizontal plane on the lateral axillary view and the calculation of the difference in the distance between the anterior edge of the acromion and the anterior edge of the clavicle (Fig. 11) showed a significant gain between the mean preoperative value (7 mm) and the 1-year postoperative value (4 mm), ($p=0.022$). In sum, there was a significant postoperative gain in all planes.

The analysis of horizontal dynamic instability, as defined by Tauber, showed a significant gain between the mean preoperative value (10°) and the 1-year postoperative value (4°), ($p=0.014$) (Fig. 12). If, as in Tauber's definition, a value greater than 12° is considered to indicate dynamic horizontal instability, four patients were in this case before surgery and only one patient after surgery.

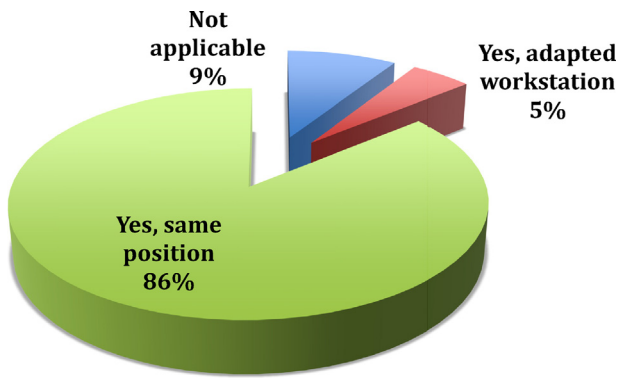


Fig. 6. Return to work.

rotation with the elbow held to the body. The mean preoperative Constant score improved from 61 to 87 at 1 year after surgery, which was statistically significant ($p=0.00002$), as was each of its parameters (Fig. 8). The mean QuickDASH subjective incapacity

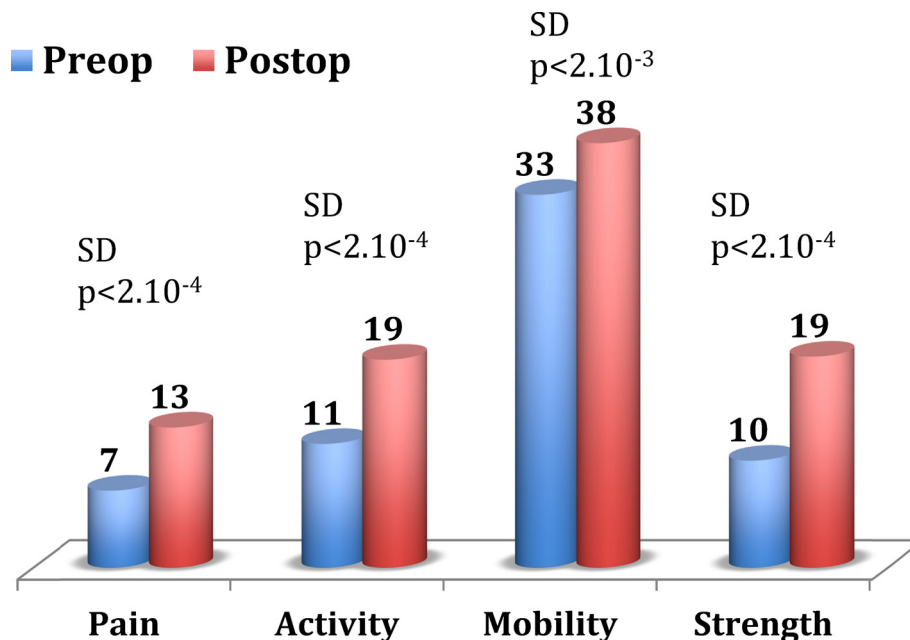


Fig. 8. Pre- and postoperative Constant score at 1 year. Preoperative mean raw Constant score = 61, postoperative mean = 87 ($p=2.10^{-4}$).

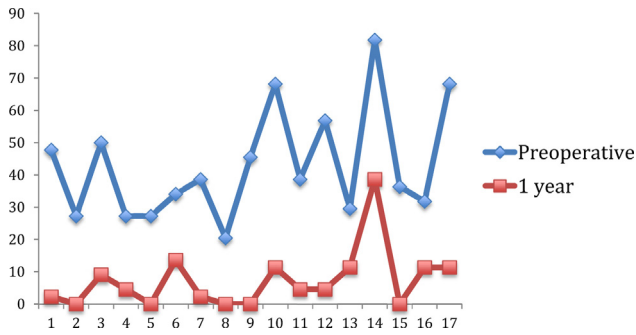


Fig. 9. Preoperative versus 1-year postoperative QuickDASH score. Mean preoperative QuickDASH was 41, mean postoperative QuickDASH was 9 ($p=2.10^{-4}$).

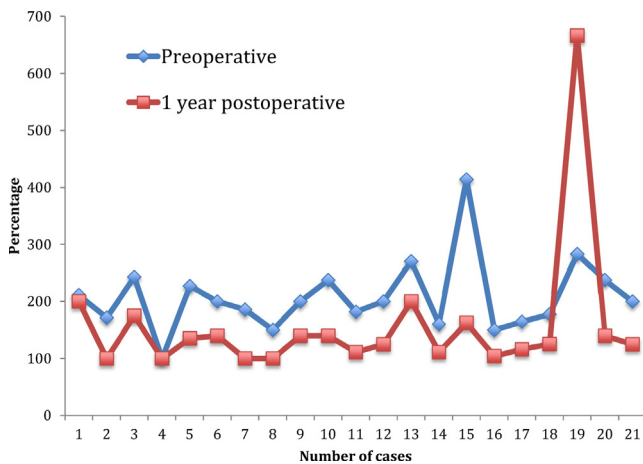


Fig. 10. AP radiological measurement of the coracoclavicular distance on the acromioclavicular joint: preoperative vs 1 year. Preoperative mean = 216%; postoperative mean = 158% ($p=2.10^{-3}$).

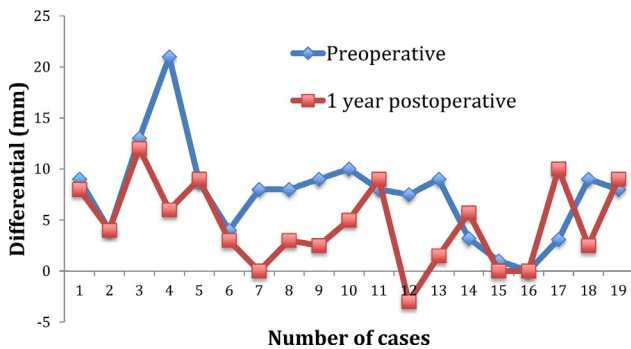


Fig. 11. Radiological measurement of horizontal movement on lateral axillary image: preoperative vs 1 year postoperative (anterior edge of acromion, anterior edge of clavicle). Preoperative mean = 7 mm, postoperative mean = 4 mm ($p=0.02$).

3.7. Analysis of the correlations

The gravity of the initial Rockwood grade, the BMI, and the context of work compensation were correlated with the Constant score at 1 year ($p=0.01$). Time to surgery influenced the radiological result. For the coracoclavicular ratio, we observed a mean 114% for time to surgery less than 3 months and a mean 183% for time to surgery greater than 3 months, but the difference was not significant. In the horizontal plane, a significant difference was demonstrated in terms of residual displacement (if time to surgery was < 3 months 202% and if time to surgery was > 3 months 341%; $p=0.02$).

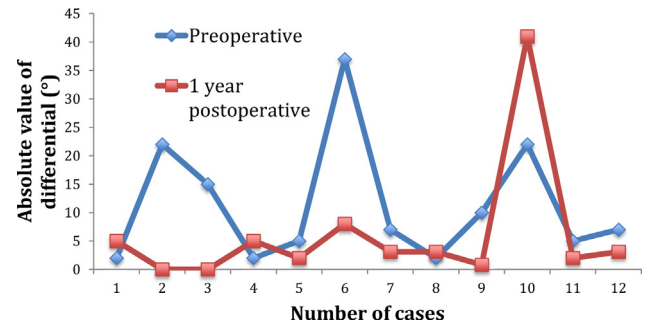


Fig. 12. Dynamic horizontal instability (Tauber protocol): preoperative vs 1-year postoperative. Mean preoperative GACA differential = 10°, mean postoperative GACA differential = 4° ($p=0.01$).

Resection of the distal extremity of the clavicle did not influence the final result at 1 year in terms of pain, the Constant score, the QuickDASH score, or acromioclavicular stability (non-significant values). Preoperative image intensifier guidance did not influence the anatomical result at 1 year (NS). The type of the graft and the type of reconstruction did not seem to influence the final anatomic result of the acromioclavicular stabilization (NS). The type of reconstruction – anatomic, non-anatomic, or combined – did not influence the functional or anatomic result (NS). Protection of the repair with a sling for 6 weeks significantly improved the functional and anatomical results ($p=0.04$).

4. Discussion

4.1. Definition of the chronicity of an ACJD

With time, the torn coracoclavicular ligaments retract and progressively resorb [2,11]. Even though it is difficult to determine a length of time between accident and surgery after which these ligaments can no longer heal despite reduction of the dislocation, many authors agree that the definition of ACJD chronicity is given from a time to surgery greater than 3 weeks [3,12–14].

Although some authors have already shown better functional results in cases of early management [3,12], we were surprised that for chronic ACJDs, time to surgery also influenced the anatomic results (in the horizontal plane). Although a chronic condition makes anatomic reduction more difficult to achieve, there are certainly sequelae related to soft tissue injury (trapezius and delto-trapezius fascia), which was not raised in the present study because there were no imaging studies evaluating soft tissues [15].

4.2. Treatment of associated lesions

We included only isolated ACJDs with no associated lesions, but they should be treated nonetheless, particularly since these patients are older (68% associated lesions in patients > 45 years vs 29% < 30 years) [3,16,17]. We decided to exclude patients who presented associated lesions to avoid introducing a bias concerning the interpretation of the results.

4.3. Biological reinforcement

To prevent anatomic failure (characterized by progressive loss of reduction) [11,18] and therefore loss of function [19], efficacy was shown to increase the biomechanic resistance of the bio-materials used to maintain the reduction of the ACJD [20–23]. Reinforcing the repair with a biological reinforcement was also suggested [1,2,24–26]. The trend of the symposium investigators clearly favored biological reinforcement in 88% of the cases. For

Yoo et al. [26], use of a biological graft was even advised in acute grades IV and V ACJDs.

4.4. Choice of biological graft

We did not observe better results in one type of reconstruction compared to another, probably because of the study's insufficient statistical power between an anatomic reconstruction with a free graft, a non-anatomic reconstruction with coracoacromial ligament transfer reinforced with a double button fixation, and a combined reconstruction (transfer of the coracoacromial ligament + palmaris longus graft + double button). In vitro, biomechanically anatomic reconstructions seem more resistant than non-anatomic Weaver-Dunn reconstructions [27]. Gutter and Petersen showed significantly lower load at failure when using a for the isolated Weaver-Dunn or an isolated palmaris longus graft procedure compared to native coracoclavicular ligaments, respectively, 483 N, 326 N, and 815 N ($p < 0.001$) [28]. On the other hand, there was no significant difference pleading in favor of a larger caliber graft such as the radial carpal flexor (774 N, $p = 0.607$). This suggests that using hamstring allo- or autografts of hamstrings tendons is preferable. Clevenger et al. showed that it is not biomechanically useful to reinforce a coracoclavicular reconstruction with transfer of the coracoacromial ligament when using hamstring tendon graft [29], but neither the Weaver-Dunn + double button fixation nor the combined reconstruction that we used was studied. Although it is certain that the sole transfer of the coracoacromial ligament is insufficient to resist strains in chronic ACJD, it remains to be demonstrated that a non-anatomic system or even better a combined system is equivalent to an anatomic system. This must also be qualified because in our cohort, coracoacromial ligament transfer was always associated with synthetic or biological reinforcement (palmaris longus).

The disadvantage of an autograft of the hamstring tendons other than increasing the complexity and duration of the intervention (wide preparation of the lower limb) also generates morbidity on the distant donor site. Use of an allograft, not routinely available in France, increases the risk of fracture (related to the size of the tunnels drilled), and the risk of disease transmission [2].

4.5. Acromioclavicular stabilization

Although acromioclavicular verification seems to be an important phase of the surgical procedure, contrary to the acute and overall series, we did not demonstrate a statistical difference with and without acromioclavicular stabilization. This is probably related to the lack of statistical power in this study.

Debski et al. [29] showed that with transection of the capsule, the conoid served as the primary restraint against anterior and superior loading, while the trapezoid functioned as the primary restraint against posterior loading. If the acromioclavicular capsule is not repaired, there are more stresses on the coracoclavicular ligaments, explaining the persistent horizontal instability, particularly with coracoclavicular stabilization using a single synthetic graft. This causes pain before complete failure of the reconstruction because of excessive sollicitation [30].

4.6. Distal clavicle excision

We found no influence of distal clavicle excision on the pain score, nor any anatomic consequence: no destabilization of the acromioclavicular joint. It should be noted that these resections were only a few millimeters, often associated with non-anatomic reconstructions to facilitate passage and healing of coracoacromial ligament transfer in the clavicle. We do not believe wider excision to be useful.

4.7. Time to treatment

We showed that good horizontal reduction was influenced by time to surgery less than 3 months ($p = 0.02$). Defining failure of functional treatment therefore should not be delayed because it becomes more difficult to control secondary reduction loss. Carofino and Mazzocca proposed systematically beginning functional treatment for all grade III and V cases of ACJD for 6–12 weeks before considering functional result failure [7]. As we have also demonstrated, they are highly prudent in terms of time to revision (6–8 weeks of immobilization with a special brace, 2 months to recover range of movement, 3 months to begin muscle strengthening, with contact sports unauthorized for 6 months).

4.8. Indication for Rockwood grade III

Given the fairly high complication rate (33%) and the fact that Schlegel et al. [6] show that subjectively 80% of grade III injuries spontaneously evolve favorably with conservative treatment, it seems logical not to indicate primary surgery for grade III injuries, clinical verification shortly thereafter (day 8) to ensure that the injury is truly a type III, and to wait until the 3rd month to discuss a surgical approach if the functional progression remains unfavorable.

4.9. Strength and limitations of the study

The strength of this study is its prospective design investigating a homogenous series (use of a biological graft in 88% of the cases) with no associated lesions and a good 1-year follow-up rate (87.5% clinical and radiological follow-up). Since patients were selected with poor progression following the conservative treatment initially prescribed, the possibility of comparing the pre- and postoperative functional scores provided an objective analysis of the gain provided by surgical treatment.

The main limitations of this study were the small sample size (< 30) limiting the study's statistical power, and the great variability of surgical treatments in terms of time to surgery (1 month to 5 years after injury).

There are undoubtedly a number of biases related to the great diversity and heterogeneity of the techniques used and the large number of investigators, as in all multicenter studies.

5. Conclusion

This study demonstrated that chronification of these lesions was a negative factor for the anatomic result. As far as possible, the decision for surgery should be made around the 3rd month to guarantee a better radiological result, particularly on the horizontal plane. Use of any biological reinforcement (anatomic or non-anatomic) greatly contributed to maintaining the reduction over time, as did visual verification and proper reduction of the acromioclavicular joint as well as a prolonged period of immobilization lasting 6 weeks. Concomitant distal clavicle excision is not necessary to reduce the pain threshold. This resection should be limited to a few millimeters to prevent bone destabilization in the joint.

Disclosure of interest

The authors declare consulting income from Arthrex (Dr. Barth) and from Mitek and Tornier (Pr. Clavert).

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