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Original article

A combined technique for acromioclavicular reconstruction after acute dislocation – technical description and functional outcomes☆

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ABSTRACT

Objective: This study aims to describe the surgical approach to such injuries and to present the clinical and functional outcomes obtained in a cohort of patients.
Methods: This is an observational retrospective study that included 153 patients with acute acromioclavicular joint dislocation, operated between 1999 and 2015. Clinical evaluation included the following outcomes: Constant functional scale, development of complications, time to return to previous work/sport activities, and satisfaction index. The contra-lateral (uninjured) shoulder was used as control in subjective outcomes. Radiological evaluation was performed in order to monitor signs of loss of reduction, degenerative joint changes, and coracoclavicular calcifications.
Results: The mean age was 29.20 ± 9.53 (16–71), with a large male predominance (91.5%). Follow-up lasted 55.41 ± 24.87 (12–108) months. The mean Constant score attained was 96.45 ± 4.00 (84–100) on operated shoulders and 98.28 ± 1.81 (93–100) on contralateral ones. Almost all patients (98.69%) were satisfied with the surgical results. Worse outcomes were observed in acromioclavicular joint dislocations of increasing grade (from type III to V, but worse for type IV), both concerning the Constant score and return to work or sport. The overall incidence of complications was considered low, with the most prevalent being Kirschner wire failure and isolated coracoclavicular ligament calcifications.
Conclusion: The surgical technique described is an excellent option in the treatment of acute acromioclavicular joint dislocations of Rockwood grades III to V. This is corroborated by the excellent clinical and functional outcomes and the low rate of complications.

☆ Study conducted at the Shoulder Unit, Orthopedics Department, University Center and Coimbra Hospital, Coimbra, Portugal.

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Técnica combinada para reconstrução acromioclavicular após luxação aguda – descrição técnica e resultados funcionais

Palavras-chave:
Luxação acromioclavicular aguda
Técnica cirúrgica
Reconstrução
Atropexia com fios de Kirschner
Síndesmopexia coracoclavicular
Transferência coracoacromial

RESUMO

Objetivo: Este estudo teve como objetivo descrever a abordagem cirúrgica das luxações acromioclaviculares agudas e apresentar os desfechos clínicos e funcionais obtidos em uma coorte de pacientes.

Métodos: Trata-se de um estudo observacional retrospectivo que incluiu 153 pacientes com luxação aguda da articulação acromioclavicular operados entre 1999 e 2015. A avaliação clínica incluiu os seguintes desfechos: escala funcional de Constant, surgimento de complicações, tempo até o retorno ao trabalho ou atividades esportivas e índice de satisfação. O ombro contralateral (não lesionado) foi utilizado como controle nos resultados subjetivos. Foi realizada avaliação radiológica para monitorar sinais de perda de redução, alterações articulares degenerativas e calcificações coracoclaviculares.

Resultados: A média de idade foi de 29,20 ± 9,53 (16 a 71), com grande predominância masculina (91,5%). O seguimento durou 55,41 ± 24,87 (12 a 108) meses. A média no escore Constant foi 96,45 ± 4,00 (84 a 100) nos ombros operados e 98,28 ± 1,81 (93 a 100) nos contralaterais. Quase todos os pacientes (98,69%) ficaram satisfeitos com os resultados da cirurgia. Luxações de articulação acromioclavicular de grau crescente (do tipo III para V, mas principalmente no tipo IV) apresentaram resultados piores, tanto no que diz respeito ao escore de Constant quanto ao retorno ao trabalho ou esporte. A incidência global de complicações foi considerada baixa, sendo que as mais prevalentes foram falha do fio de Kirschner e calcificações isoladas do ligamento coracoclavicular.

Conclusão: A técnica cirúrgica descrita é uma excelente opção no tratamento de luxações agudas de articulações acromioclaviculares classificadas como graus III a V na escala de Rockwood. Essa conclusão é corroborada pelos excelentes resultados clínicos e funcionais e pela baixa taxa de complicações.

Introduction

Acromioclavicular joint dislocations (ACJD) follow injuries to the static stabilizers of the acromioclavicular joint (ACJ). These are the superior, inferior, anterior and posterior AC ligaments, that prevent excessive movement on the horizontal plane, and the coracoclavicular ligaments (CCL) that mainly provide vertical stability.[1,2] Classification systems initially proposed by Allman and Tossy and later by Rockwood are anatomically based and currently guide the treatment in ACJD.[3,4]

Few injuries in the orthopaedic field had so many and so different treatment options as the ACJD, which means that there is not a standard 'best treatment' for this condition. More than 35 conservative treatment options and hundreds of different surgical approaches can be found in the literature.[2,3]

It is widely accepted that Rockwood types I and II are treated conservatively and that types IV-VI require surgery. Type III injuries treatment is controversial. Multiple surgical approaches have previously been described. Ultimately they all intend to reduce the dislocation, allow soft tissues' proper healing and stabilize the distal clavicle.[5–8]

We aim to describe the Shoulder Unit of Coimbra University Hospitals (HUC) Surgical Technique for ACJ Reconstruction after ACJD and to present the clinical and functional outcomes obtained in a cohort of patients.

Methods

We retrospectively evaluated 153 patients with ACJD, operated with our surgical technique for ACJ reconstruction during 1999 and 2015.

We included patients with ACJD that underwent surgery at least 1 year ago, had no contralateral shoulder complaints or pathology and had no other pathologies in both superior limbs.

Clinical evaluation encompassed objective and subjective outcomes. We used the following outcomes: Constant Score (CS)[9]; the presence of early and late complications; satisfaction index. Radiological evaluation included bilateral anteroposterior views of the clavicles to search for signs of loss of reduction (defined as more than 25% increase of the coracoclavicular (CC) distance achieved between the immediate post-operative period and the last follow-up visit), joint degenerative changes and coracoclavicular calcifications. Contra-lateral (uninjured) shoulders were used as control in subjective outcomes. For statistical analysis we used SPSS (version23, IBM Corp, Armonk, New York).

For continuous variables we used average and measures of dispersion (standard deviation, minimum and maximum) with confidence interval set at 95%. Frequencies and their respective percentages were calculated for nominal variables.

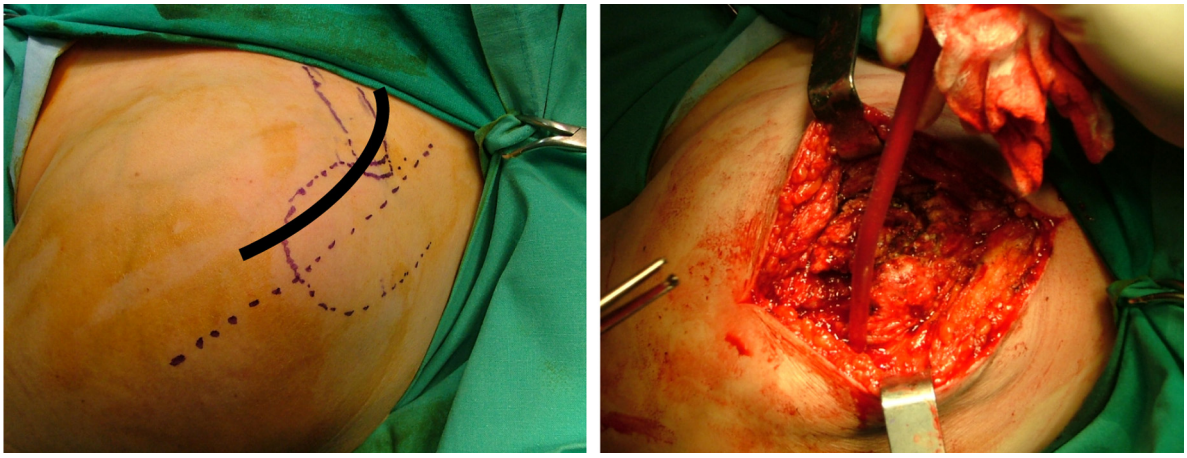

Fig. 1 – Surgical approach. Black line depicts incision line.

To compare quantitative measurements we used *t*-student test. When the groups were small and had no normal distribution, Mann–Whitney test was chosen. To compare a continuous dependent variable by a grouping independent variable with three groups we used Kruskal–Wallis test. P values below 0.05 were considered statistically significant and we estimated statistical power to be 0.8 (α-error: 0.05). This study was approved by our institution and all patients signed informed consent.

Shoulder Unit of Coimbra University Hospitals (HUC) surgical technique for ACJ Reconstruction after ACJD

A reconstruction technique to the ACJ that congregates other commonly used techniques has been used in the Shoulder Unit of Coimbra University Hospitals (HUC) since 1987. Initially devised by Braz Cardoso, it has been used since then and developed by the Shoulder Unit team. The main goal of this technique is to restore normal anatomy of the ACJ, recover stability, strength and function.

Surgery is performed under brachial plexus blockade, with associated general anaesthesia whenever necessary. The patient is positioned semi-seated with the head laterally tilted to the opposite side, allowing good anterior and posterior shoulder exposure. Surgical approach involves a transverse arcuate incision centred on the ACJ that stretches from the acromion to the coracoid process (Fig. 1). Usually we have to detach the trapezium and the anterior deltoid from the distal clavicle. First we examine the ACJ and look for ligamentous and articular meniscus injuries (Fig. 2).

This surgical technique encompasses 3 fundamental steps:

- **Coracoacromial ligament transfer** (Fig. 3): After detachment of this ligament with a small bone block, a suture is passed through it, allowing traction and anchorage on the previously cruented inferior surface of the clavicle. Two small hole drills, located at the previous coracoclavicular ligaments insertion site at the clavicle, allow future passage of the identified coracoacromial ligament.
- **Extra-articular proceeding** (Fig. 4): This step focuses in the coracoclavicular space. While maintaining its dimension and avoiding excessive tension, we perform a coracoclavicular sindesmopexy with a tangled loop suture that goes under the coracoid and around the clavicle.
- **Intra-articular proceeding** (Fig. 5): After reduction of the ACJ, the articular meniscus should be repositioned in order to avoid arthritis development. Then, ACJ stabilization is accomplished by insertion of 2 Kirschner wires (K-wires) (AC arthropexy), bent and impacted on the lateral extremities to avoid medial migration. ACJ articular capsule and ligament repair are performed (Fig. 6).

Routinely we perform radiological post-operative control. Initially the shoulder is immobilized with a sling, allowing pendular shoulder movements. Around the 4–6th week K-wires are extracted. Until then we limit active shoulder elevation and abdution to 90°.

Results

The cohort included 153 operated patients. 140 (91.5%) were male, mean age by the time of surgery was 29.20 ± 9.53 (16–71) years and ACJD occurred in the dominant arm in 87.6% of the cases ($n = 134$).

Most frequent causes were falls ($n = 90$; 62.75%), followed by sports injuries ($n = 41$; 26.80%) and road accidents ($n = 16$; 10.46%). ACJD was not associated with concomitant injuries in 89.54% of the cases. In the remaining patients reported injuries were non-shoulder related.

According to Rockwood classification there were 113 type III (73.86%) injuries, 11 (7.19%) type IV and 29 (19%) type V.

Average time between injury and surgery was 1.88 ± 0.87 (1–6) weeks. Mean time to return to work was 3.65 ± 0.71 (3–4) months while 4.61 ± 0.73 (4–6) months were necessary to resume full sports participation. Mean follow-up time was 55.41 ± 24.87 (12–108) months.

Final CS averages 96.45 ± 4.00 (84–100) in operated and 98.28 ± 1.81 (93–100) in the control shoulders, representing a significant difference ($p < 0.001$) (Figs. 7 and 8). We applied the

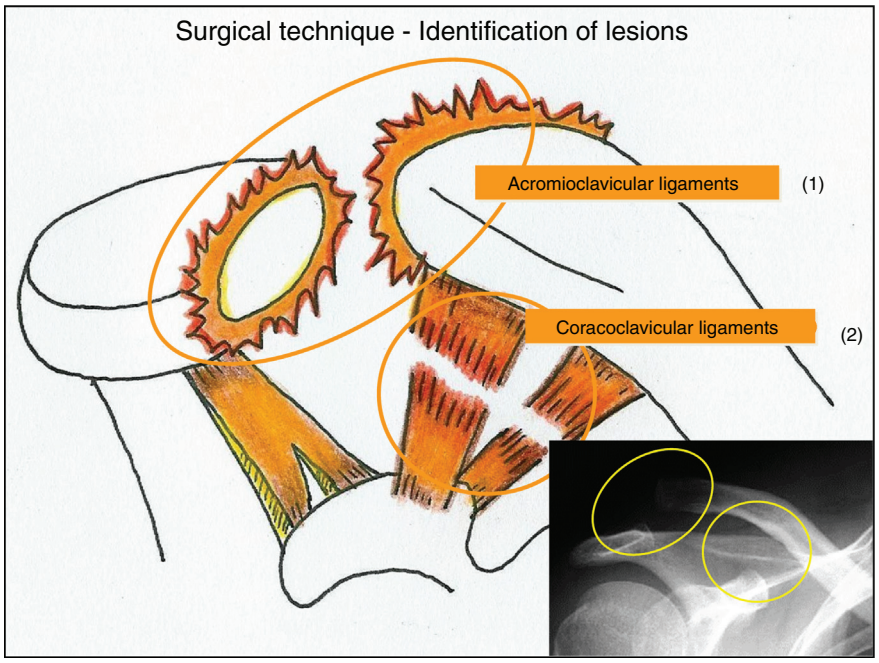

Fig. 2 – Injury identification: 1 – ruptured acromioclavicular ligaments; 2 – ruptured coracoclavicular ligaments. Radiograph showing a type III acromioclavicular dislocation.

Neer Score[10] that categorizes results as excellent (100–90), satisfactory (89–80), unsatisfactory (79–70) and failure (<70). 140 (91.5%) patients had excellent results and the remaining 13 (8.5%) were classified as satisfactory results.

Progression in Rockwood classification from types III to V was associated with worse functional outcomes, as we can see by the CS final values of each type (Table 1). Most significant differences were found between types III and IV, namely concerning return to work (3.52 ± 0.76 vs 4.00 ± 0; $p = 0.009$), return to sports (4.57 ± 0.73 vs 5.57 ± 0.53; $p = 0.003$) and the CS the CS sub-parameter "Arm Positioning pain" (9.73 ± 0.68 vs 8.73 ± 1.01; $p < 0.001$).

Almost all the patients (98.69%) were satisfied with the surgical outcomes.

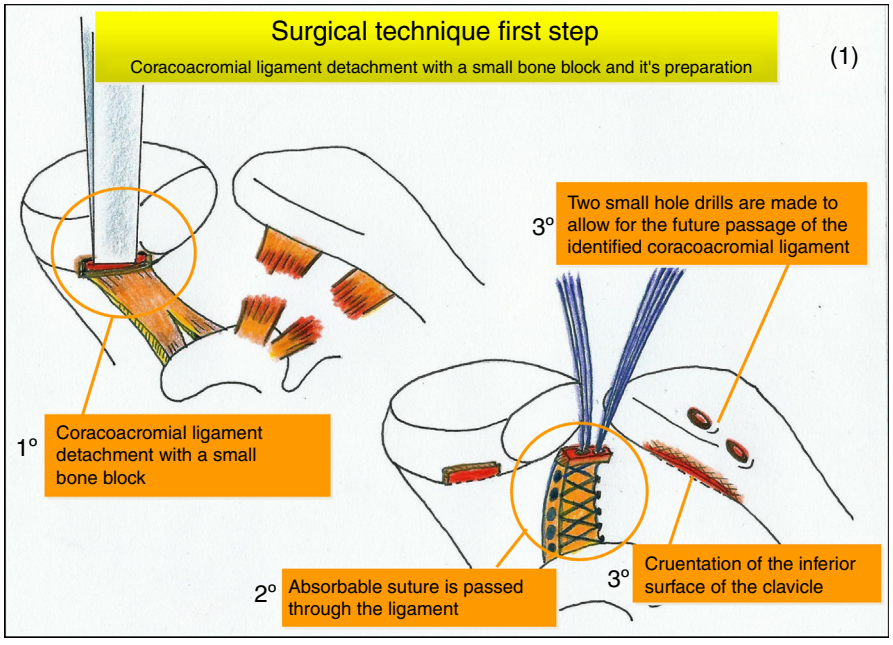

Fig. 3 – (1) Surgical technique first step – 1° – coracoacromial ligament detachment with a small bone block; 2° – absorbable suture is passed through the ligament; 3° – cruentation of the inferior surface of the clavicle. Two small hole drills (at the previous coracoclavicular ligaments insertion site) are made to allow for the future passage of the identified coracoacromial ligament.

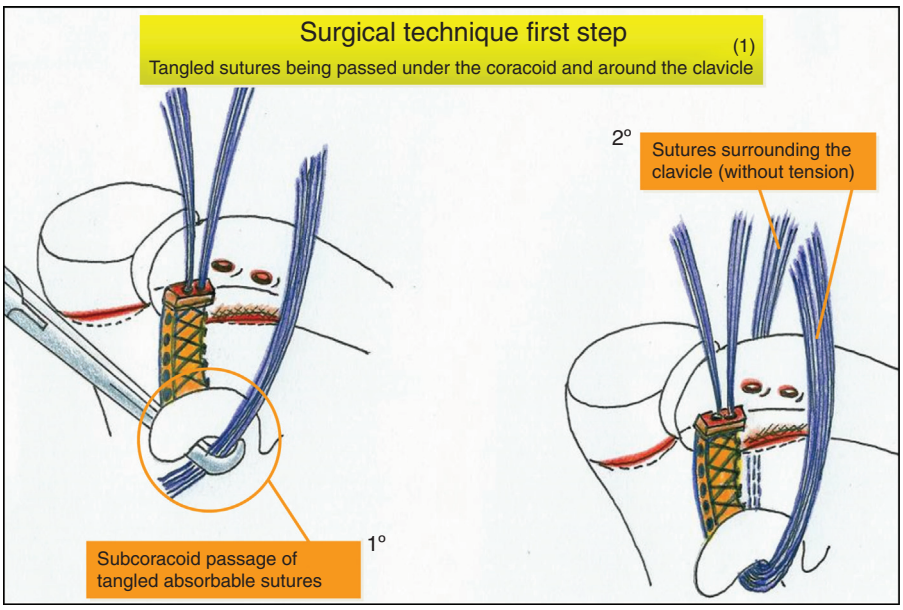

Fig. 4 – (1) First step – extra-articular proceeding: tangled sutures being passed under the coracoid and around the clavicle; 1° – subcoracoid passage of tangled absorbable sutures; 2° – sutures surrounding the clavicle (without tension) would constitute the coracoclavicular stabilization.

Table 1 – Comparison between CS final values attained according to Rockwood injury type/classification.

		Mean Final Constant Score	Mean Final Constant Score standard deviation
Rockwood tipo III	Operated shoulder	96.75	3.89
Rockwood tipo IV	Operated shoulder	95.45	2.70
Rockwood tipo V	Operated shoulder	95.66	4.77

Immediate complications reported included hypertrophic scar ($n = 11$; 7.19%), superficial infection ($n = 8$; 5.23%), K-wire failure ($n = 14$; 9.15%) and external K-wire migration ($n = 5$; 3.28%). 75.16% ($n = 115$) had no immediate complications. Regarding late complications, isolated CCL calcifications ($n = 32$; 20.91%) was by far the commonest, followed by residual deformity caused by slight loss of reduction (increase of CC distance between 25% and 50% in all the loss of reduction

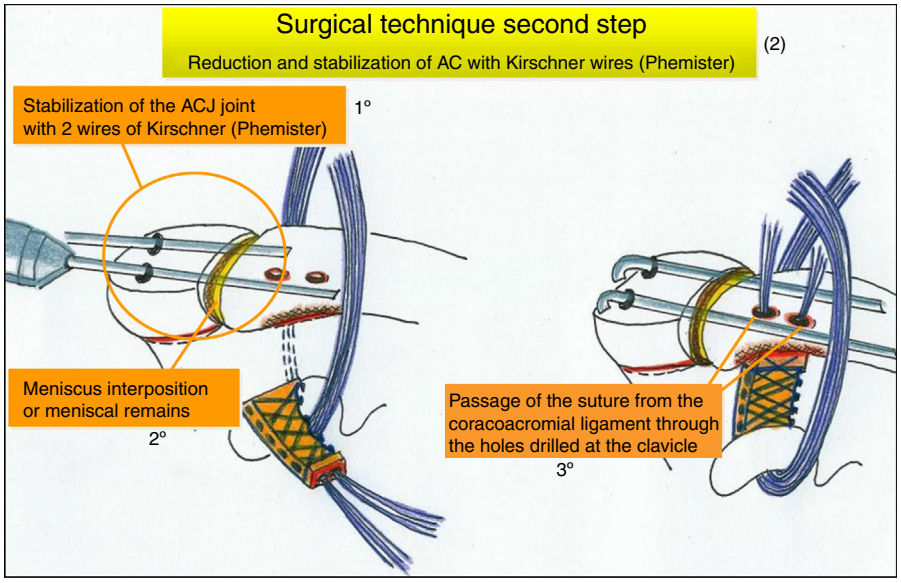

Fig. 5 – (2) Second step – intra-articular proceeding: 1° – reduction and stabilization of the ACJ with Kirschner wires; 2° – meniscus (or its reminiscent) interposal in AC; 3° – passage of the suture from the coracoacromial ligament through the holes drilled at the clavicle.

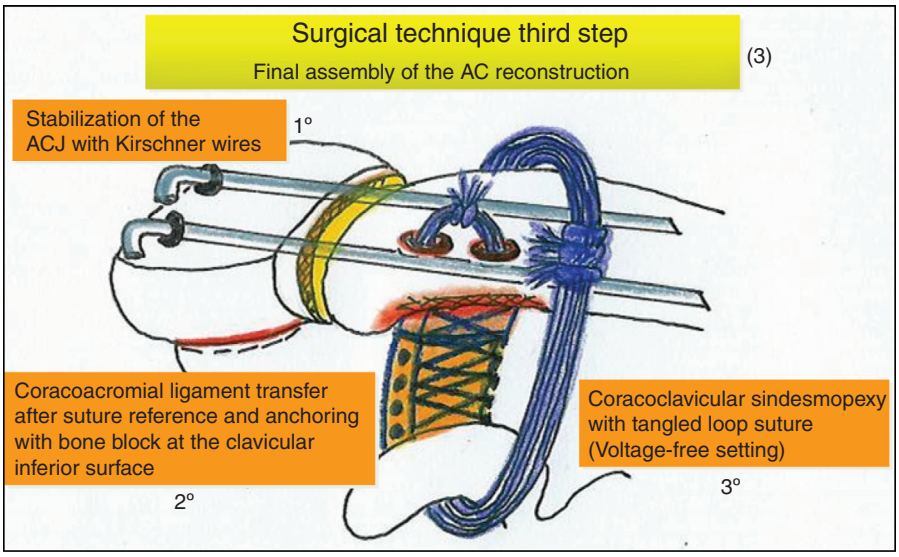

Fig. 6 – (3) Final assembly of the AC reconstruction: 1° – stabilization of the ACJ with Kirschner wires (AC arthropexy); 2° – coracoacromial ligament transfer after suture reference and anchoring with bone block at the clavicular inferior surface; 3° – coracoclavicular sindesmopexy with tangled loop suture.

cases) ($n = 9$; 5.88%). Both complications occurred in 3 patients (1.96%). The majority ($n = 109$; 71.24%) of the cohort had no late complications. Mean CS of patients who developed complications was significantly worse than those who did not (91.73 vs 97.42) ($p < 0.001$). Radiographic evaluation revealed no cases of arthritis development.

Discussion

The multiple existing surgical options to treat ACJD reflect the difficulties in restoring the intricate biomechanics of this joint complex. The methods traditionally described usually involve ligament reconstruction and transfer, coracoclavicular and ACJ stabilization and fixation and sometimes distal clavicle excision. Most authors present good and excellent results with different methods. Regardless, all of the above techniques are associated with important complications when they are used in isolation.[11,12]

Coraco-acromial ligament transfer advantages include the fact it restores normal anatomy, induces few degenerative

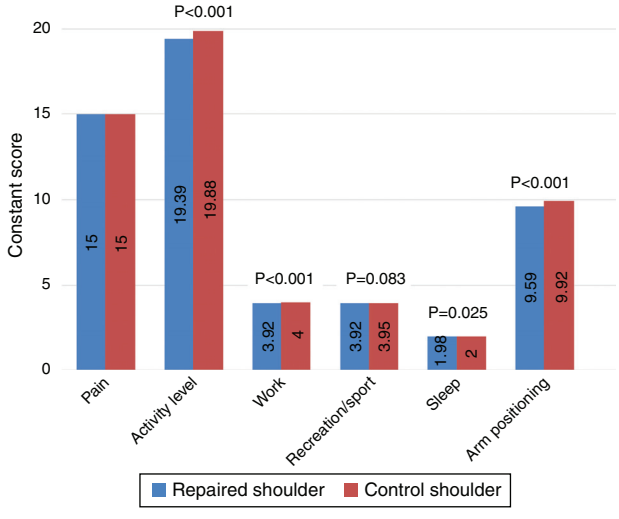

Fig. 7 – Comparison between repaired and control shoulders regarding constant score parameters "Pain" and "Activity level". Inside the bars are the mean score values for each parameter and upside each two bars are the p significance value for the difference between repaired and control shoulders.

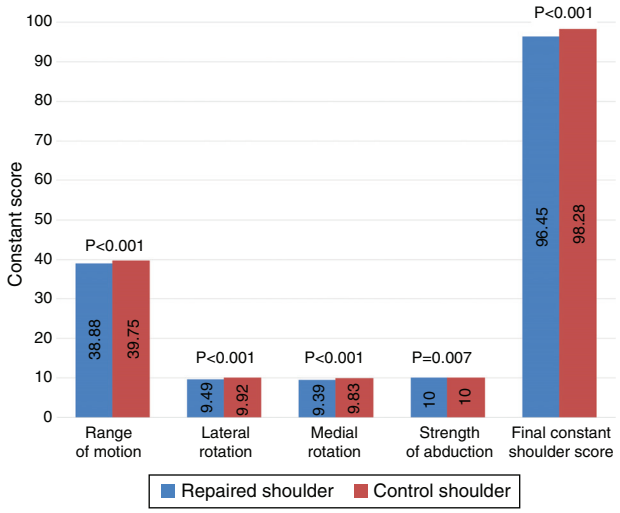

Fig. 8 – Comparison between repaired and control shoulders regarding constant score parameters "Range of motion", "Strength of Abduction" and the "Final Constant Score". Inside the bars are the mean score values for each parameter and upside each two bars are the p significance level for the difference between repaired and control shoulders.

changes and has a low loss of reduction rate. Nowadays ligament transfer is not performed isolatedly, as the scar needs time to mature.[13,14] K-wires arthropexy of ACJ (Phemister technique) allows temporary initial fixation but has some accompanying risk, including arthritis (when the meniscus is not reposed or articular space is insufficient for normal ACJ cinematics), migration and need of a second intervention by the 4th to 6th week. Moreover, it is not uncommon to see loss of reduction when this procedure is used alone.[11,15,16] Coracoclavicular sindesmopexy provides good early fixation, allowing clavicle rotation, but it is associated with frequent loss of reduction, lack of horizontal stability and degenerative changes.[15,17,18] When performed with non-absorbable sutures it becomes more durable. However it favours clavicular osteolysis and associated stress fractures. If the surgeon opts for absorbable sutures, the opposite is expected.[8,15] Coracoclavicular screw fixation was initially described by Bosworth. It has been the most commonly used technique for temporary fixation of the ACJ. Although it allows an efficient fixation, it is technically demanding as it requires correct positioning of the screw on the small horizontal surface of the coracoid process. Even when accurately performed we may expect high rates of osteolysis, material disruption and migration and loss of reduction when material is removed.[11,19] Dynamic compression plates modified with hook provides good stability but may lead to the development of stiffness, clavicular osteolysis and fractures. Furthermore, they do not allow rotational movements and a second intervention for removal is required.[20–22] Arthroscopy and other minimally invasive methods are constantly being developed, however it is yet to determine if these recent approaches allow equivalent or superior results (and complication rates) as compared to the traditional ones.[11] All the above described techniques are associated with important complications when they are used in isolation.[11,12]

The Shoulder Unit of Coimbra University Hospitals Surgical Technique for ACJ Reconstruction is a combined technique of commonly isolated techniques, which attempts to restore normal anatomy, stability, strength and function of AC. The above described surgical technique has been successfully used in our shoulder unit for a few decades. We decided to perform a retrospective evaluation that ultimately confirmed our subjective impression of excellent clinical and functional outcomes and a low rate of complications. Our rationale is that arthropexy with K-wires and coraco-clavicular loop suture provide stability of the ACJ granting adequate healing period (approximately 4–6 weeks) to the transferred coracoclavicular ligament, the repaired ACJ ligaments and the articular capsule. When the K-wires are removed, they are already able to bear some load while still 'protected' by the coracoclavicular stabilization loop suture. By the time coracoclavicular stabilizing suture is absorbed, the AC capsulo-ligamentar complex is already healed and able to tolerate load (Fig. 9). Advantages of our technique include: early mobilization (90° elevation until K-wire removal and then more); fast return to work and sports; absence of pain; no reported re-dislocations; no acceleration of arthritis process; excellent clinical and functional outcomes. Potential disadvantages derive from the fact this is a mixture of various classical techniques: it may be technically difficult, demanding longer surgical exposure (60–90 min) and higher soft tissue manipulation. It also requires in-depth anatomical knowledge and a second procedure for K-wires removal.

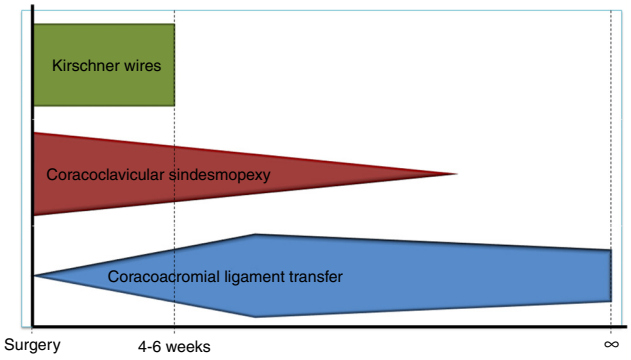

Fig. 9 – Diagrammatic representation of stability to AC provided by the 3 techniques combination during post-operative period.

Most of the present study limitations derive from its retrospective nature. Moreover subjective clinical assessment was based exclusively in the CS, limiting comparisons with studies that may have used different outcome measurements. It would be interesting to compare this technique with others currently used in a prospective randomized controlled trial.

Conclusion

We conclude that the surgical technique we describe for ACJ Reconstruction is an excellent option in the treatment of ACJD of Rockwood grades III to V, which is corroborated by the excellent clinical and functional outcomes and the low rate of complications.

Conflicts of interest

The authors declare no conflicts of interest.

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