

Arthroscopic acromioclavicular joint reconstruction using a synthetic ligament device

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Abstract

Purpose To describe an all-arthroscopic treatment of acromioclavicular joint (ACJ) dislocation and report the clinical results of the procedure.

Methods This study consisted of 54 patients of whom 49 were men and 5 were women. The age of the patients averaged 39 years (range 16–69 years). All the symptomatic acute and chronic acromioclavicular joint dislocations classified according to Rockwood type III–IV were included in the study. All of them underwent standard clinical and radiological examination.

Result All the patients were regularly followed up at the institute with the average follow-up being 15.09 months (range 5–30 months). The results were assessed using the shoulder subjective value (SSV) and the Modified rating of the University of California Los Angeles (UCLA) for acromioclavicular joint. The mean pre-operative SSV improved from 35.65 to the post-operative value of 88.6. According to the UCLA scale, 40 excellent, 8 good, 4 fair and 2 poor results were achieved. There were few problems encountered with the procedure like failure of ligament, incomplete reduction, capsulitis, and migration of sleeve and fracture clavicle.

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Conclusion ACJ dislocations can effectively be treated with arthroscopy-assisted procedure. Since this procedure has given uniformly good to excellent results comparable to open reconstructive procedures, it can be a good treatment option for symptomatic ACJ dislocations.

Level of evidence IV, therapeutic series.

Keywords Arthroscopy · Acromioclavicular joint dislocation · Coracoclavicular ligament · Synthetic ligament

Introduction

Acromioclavicular (AC) joint injuries occur most commonly due to direct force on the lateral aspect of the adducted shoulder. This can occur during a sporting activity or a MVA (motor vehicle accident); depending on the force applied, there is complete disruption of the acromioclavicular ligament or coracoclavicular (CC) ligaments [1, 11].

The AC ligament controls the horizontal motion, and the CC ligaments control the vertical motion as they synergistically function to stabilize the AC joint [12]. The conoid ligament controls superior and anterior displacement, whereas the trapezoid ligament controls the posterior displacement, which is the reason for anatomic approach in reconstructing the dislocated AC joint [9].

In Rockwood (RW) type I, II dislocation, nonoperative treatment gives satisfactory result [10]. The treatment for RW III varies widely, depending on the age, physical demand, symptom and cosmesis. An acute RW III injury is an indication for surgery if patient is symptomatic and functionally disabled [10]. Acute RW IV–VI are absolute indications for surgery. Injuries more than 6 weeks are

considered to be chronic, and RW III–VI are stabilized surgically only if pain, paraesthesia and reduced mobility are encountered. Both conservative and operative approaches have their advantage and disadvantage. Conservative treatment can lead to disabling pain, joint osteolysis and cosmetic deformity of the AC joint, while an operative approach can cause joint deformity, osteoarthritis and failure of hardware [16, 25].

However, newer anatomic techniques are being adopted to reduce complication and improve the outcome by using both biological and non-biological tissue for treatment [21, 23, 29, 31]. Keeping in line with the concept Wolf and Pennington were the first to develop arthroscopic technique to treat AC joint dislocation [33]. The decision to stabilize the dislocated AC joint arthroscopically was undertaken to minimize the soft tissue dissection, scarring, deformity and to have a better functional outcome.

The purpose for this study was to assess whether the usage of synthetic ligament provides results on par with the open procedures and evaluate the outcome with regard to arthroscopic reconstruction of AC joint dislocation.

Materials and methods

In a retrospective study from October 2008 to April 2010, the treatment of 58 patients with symptomatic acromioclavicular (AC) joint dislocation was evaluated following arthroscopic reconstruction of coracoclavicular ligaments. All the patients with symptomatic acute and chronic AC joint dislocation were included in the study. All the cases with associated injuries of the arm and shoulder, those who did not follow up, were excluded from the study. This was done using a synthetic 200-mm-long double-braided polyester tape (polyethylene terephthalate, SEM, SEM LAC 2T, Montrouge, France) with pre-assembled 8-mm-diameter sleeve at one end and polyester traction suture at other end. A stainless steel straight sleeve with a crimping cone is used to secure the other end of the ligament (Fig. 1).

The rationale for using the ligament is to use a tissue close to the failure load of the natural coracoclavicular (CC) ligament. The load to failure of CC ligaments is 589 N, AC joint complex is 815 N, and Weaver–Dunn procedure is 483 N [14, 17]. The load to failure of the ligament SEM LAC 2T is 500 N. It is known that fibrous tissue proliferates between the coracoid and the clavicle once the AC joint complex is stabilized satisfactorily [7]. The ligament SEM LAC 2T can also act like a scaffold for this process while stabilizing the AC joint dislocation.

Of the 58 patients, 2 were lost for follow-up, one died because of natural cause, and another had additional scapula fracture with cervical spine injury. Hence, 54 patients remained for the study of which 49 were men and



Fig. 1 Ligament SEM LAC 2T. Stainless steel sleeve and crimping cone

5 were women. The average age was 39 years (range 16–69 years). The right-side injuries were seen in 34 patients and left side in 20 patients. The time from injury to treatment averaged 3.8 months (range 0.2–24 months). Most injuries occurred due to rugby ($n = 16$) followed by fall from motorbike ($n = 9$), bicycle ($n = 7$) and others as shown in Table 1. We followed the Rockwood classification for AC joint injury [27] and Rockwood type III injury were seen in 37 patients of whom 22 were acute injuries and 15 chronic injuries. Rockwood type IV injury was seen in 17 patients of whom 6 were acute and 11 were chronic injuries. All the patients with persistent pain, discomfort, functional disability and concerns with cosmesis were only offered surgery. A standard clinical and radiological examination for all patients was done as suggested by Mazzocca et al. [24]. The ACJ was assessed for closed reduction before and under anaesthesia, if the reduction is not possibly a Weaver–Dunn procedure and debridement of AC joint is added in addition to reconstruction of CC ligaments.

All of them were regularly followed up at an average period of 15.09 months (range 5–30 months; Table 1). The local institution review board approved the study, and all the patients had given written informed consent for the study. The ligament SEM LAC 2T was used to reconstruct the CC ligament in all patients. However, 16 chronic injuries (8 RW type III and 8 RW type IV) underwent Weaver–Dunn procedure, and distal clavicle resection was done in 2 patients in addition to CC ligament reconstruction as the reduction of joint pre-operatively was difficult.

Operative technique

The procedure is performed in standard beach chair position with a cushion under the scapula of the affected

Table 1 Patient data

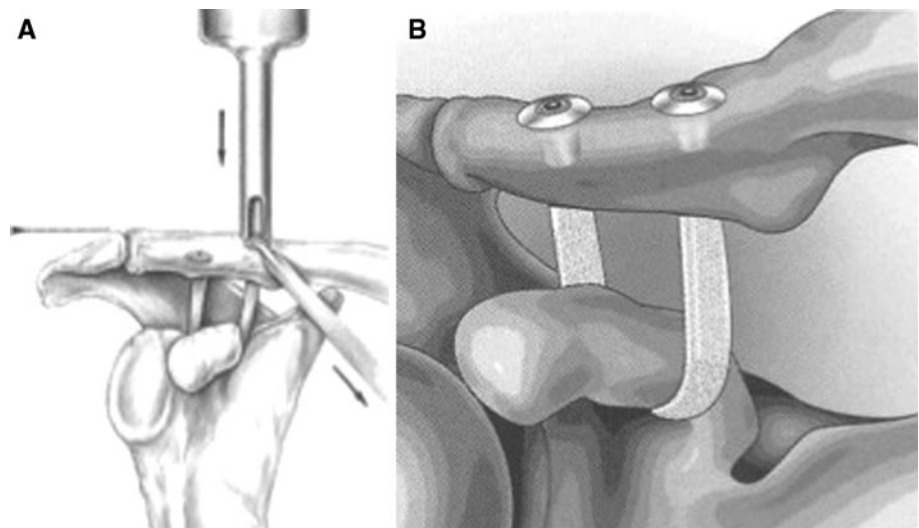
No	Age	Sex	Side	RW	MI type	Time I.T	WD	Mumford	SSV pre-op	SSV post-op	UCLA	RTS	FU months
1	40	F	L	3	Bicycle	12	N	N	50	100	20	Y	25
2	44	M	R	3	Rugby	2	N	N	50	100	20	Y	24
3	45	M	R	3	Rugby	0.2	N	N	20	100	20	Y	24
4	21	M	L	3	Rugby	2	N	N	50	80	16	N	24
5	45	M	R	3	Karate	0.3	N	N	50	90	18	Y	23
6	69	M	R	3	Bicycle	3	Y	N	80	100	20	Y	22
7	19	M	R	3	Rugby	0.2	N	N	50	100	20	Y	21
8	39	M	R	4	Ski	9	Y	N	40	80	15	N	21
9	31	M	R	3	MVA	0.2	N	N	30	80	17	N	22
10	25	M	L	3	Motorbike	0.2	N	N	60	100	20	Y	17
11	49	M	R	3	Ski	6	Y	N	35	100	18	Y	15
12	32	M	R	3	Motorbike	0.2	N	N	40	100	20	Y	14
13	67	M	R	4	Bicycle	8	Y	N	40	100	20	Y	14
14	29	M	R	3	Motorbike	1	N	N	30	100	20	Y	14
15	40	M	R	3	Motorbike	24	Y	N	50	100	20	Y	12
16	37	M	R	3	Rugby	0.2	N	N	40	100	20	Y	12
17	23	M	L	4	Handball	6	N	N	30	80	15	Y	9
18	51	M	R	4	Self fall	5	N	N	50	95	20	Y	8
19	20	M	R	3	Judo	6	Y	N	50	90	20	Y	6
20	33	M	L	4	Rugby	12	Y	N	40	90	18	N	5
21	31	M	R	3	Rugby	2	N	N	40	80	20	Y	24
22	39	M	R	3	Rugby	0.3	N	N	30	90	20	Y	23
23	39	M	L	3	Judo	4	N	N	60	100	18	Y	22
24	25	M	L	3	Rugby	0.2	N	N	60	100	18	Y	21
25	25	M	R	3	Self fall	0.3	N	N	30	100	18	Y	19
26	54	M	L	3	MVA	0.3	Y	N	20	60	13	N	19
27	24	M	L	3	Rugby	0.3	N	N	40	100	20	Y	17
28	45	M	L	3	Rugby	0.3	N	N	40	90	20	Y	15
29	54	M	L	4	Bicycle	0.3	Y	N	40	60	10	N	14
30	46	M	L	3	MVA	0.3	N	N	20	90	18	Y	13
31	45	M	L	4	Street fight	3	Y	N	30	80	15	N	13
32	55	M	L	4	Bicycle	0.6	N	N	20	80	10	N	12
33	24	M	L	3	Self fall	0.6	N	N	20	90	20	Y	12
34	31	M	R	3	Rugby	1	N	N	20	90	20	Y	12
35	48	M	R	3	Bicycle	0.6	N	N	30	75	13	N	11
36	39	M	R	3	Motorbike	4	N	Y	50	90	15	N	8
37	44	M	R	3	Rugby	0.7	N	Y	50	90	20	Y	6
38	43	M	R	4	Rugby	12	Y	N	50	70	14	N	6
39	16	M	R	3	Judo	0.5	N	N	30	100	20	Y	6
40	30	M	R	3	Rugby	0.4	N	N	20	80	17	Y	6
41	24	M	R	3	MVA	0.7	N	N	30	75	14	N	6
42	43	M	L	4	Motorbike	6	Y	Y	20	80	20	Y	6
43	47	F	L	3	Fall	6	Y	Y	20	90	20	Y	7
44	46	M	R	4	Judo	24	Y	Y	30	80	20	Y	8
45	49	F	L	3	Motorbike	6	Y	Y	40	90	20	Y	9
46	54	F	R	3	Fall	12	Y	Y	20	90	20	Y	12
47	40	M	R	4	Motorbike	0.3	N	N	20	70	15	N	16
48	60	M	L	4	Motorbike	0.3	N	N	20	80	18	Y	16

Table 1 continued

No	Age	Sex	Side	RW	MI type	Time I.T	WD	Mumford	SSV pre-op	SSV post-op	UCLA	RTS	FU months
49	30	M	L	4	Ski	0.5	N	N	20	90	20	Y	12
50	37	M	R	3	Horse	6	N	N	30	90	20	Y	18
51	23	M	R	3	Snowboard	5	Y	Y	20	80	20	Y	20
52	32	F	R	4	Rugby	0.3	N	N	20	90	20	Y	20
53	62	M	R	4	Ski	2	N	N	30	90	20	Y	24
54	37	M	R	4	Bicycle	9	Y	Y	20	90	20	Y	30

RW Rockwood type, MI mode of injury, I-T injury to treatment, WD Weaver–Dunn, SSV shoulder subjective value, UCLA University of Los Angeles, RTS return to sports, FU follow-up, MVA motor vehicle accident, Y yes, N no

Fig. 2 **a** Figure depicting reduction with sleeve pusher. **b** Final AC joint reduction appearance using Ligament SEM LAC 2T



shoulder. Surgery is performed under controlled hypotension and a combination of regional and general anaesthesia for better visualization and post-operative recovery.

Two stab incisions are made on the superior surface of the clavicle at 2–2.5 cm (A-Fig. 3b) and 4–4.5 cm (B-Fig. 3b) distance from the lateral end of the clavicle. Portals ‘C’ and ‘D’ are made inferiorly three to four finger breadth in line with the ‘A’ and ‘B’ stab incisions to allow for debridement and managing shuttle relay. The ‘E’ portal (Fig. 3b) at three to four finger breadths in line with the ‘D’ portal is the viewing portal. The most medial one (B) is posterior, oblique and the lateral (A) one little antero-central to simulate the origin of the native CC ligaments. Two drill holes are made using 3.2-mm drill bits, which are left in situ for later identification in the sub-clavicle space. Care is taken to avoid neurovascular injury while clearing the subcoracoid bursa with radio-frequency device and optimizing the lateral edge of coracoid with shaver. A diligent clearance of the soft tissue is done around the coracoid to allow easy passage of graft. The superior hole in the clavicle is enlarged using a sleeve trocar manually. The suture passer and the No 2 monofilament are used to shuttle relay the SEM LAC 2T around the coracoid while viewing

from the anterolateral portal. Second sleeve is inserted over the traction suture, and the AC joint is held reduced by pressure on the clavicle with the sleeve pusher and counter on the elbow to lift the shoulder (Fig. 2). It is preferable to use the sleeve pusher on the medial most entry to avoid unexpected failure of clavicle in weak bone. The distance between the inferior aspect of the clavicle and the superior surface of the coracoid is between 3 and 5 mm [3, 18]. Adequate reduction is checked by arthroscopy, when it should be difficult to pass a 5.5-mm shaver between the inferior surface of clavicle and superior surface of coracoid. This technique of assessing the reduction has allowed us to avoid intraoperative X-ray control or use of fluoroscopy. The crimping cone is used to secure the ligament in the sleeve, and excess is cut flush with the sleeve. The portals are closed and dressed. Please note that no dissection of the rotator interval is done to identify the coracoid or of the delto-trapezial fascia (Operative Video).

Post-operative rehabilitation

Post-operatively, the arm is placed in a sling for 3–4 weeks. Passive motion of the shoulder is encouraged

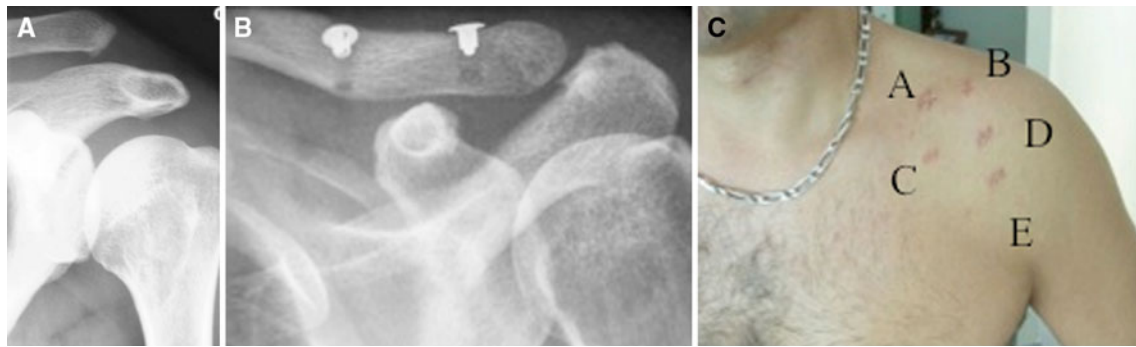


Fig. 3 a Rockwood type III AC injury in a left shoulder. b Post-surgery follow-up X-ray 9 months. c Healed portals (A, B, C, D and E) and good cosmetic result

from day 1. Over the next 3–4 weeks, they are allowed to do most activities of daily living but without resistance and lifting any heavy object. From 5 to 8 weeks, strengthening exercises and movement against resistance are encouraged. Return to contact sport and overhead activity is allowed by 3–6 months. In those cases where the Weaver–Dunn procedure is done, an additional 3 months is awaited for maturity of the bio-graft for return to sport and overhead activity.

Outcome assessment

All the patients were seen at the institution for regular follow-up, clinical examination with standard radiographs for joint reduction or any other complication. The shoulder subjective value (SSV) is the patients' self-rated subjective assessment of his or her shoulder function as compared to normal shoulder. The SSV is known to correlate well with the Constant score and is expressed as a percentage [13]. A modified scale of University of Los Angeles for AC joint (UCLA) was also used to see the overall function and patient satisfaction which is expressed as a numeric value from 0 to 20 [15].

Result

The patients were regularly followed up with clinical and radiological examination. There was no significant difference in the range of motion pre-operatively or post-operatively. The mean SSV improved from 35.65% (range 20–80%) pre-operatively to 88.6% (range 70–100%) post-operatively. The mean UCLA modified AC rating scale was 18.2 points (range 10–20 points) out of the 20 points. Most patients recovered well from the procedure with the improvement in clinical symptoms, radiological finding and cosmetic appearance (good to excellent 88% approximately) (Fig. 3). However, there were few patients who did not show encouraging results

(fair to poor 11% approximately). The complications that were seen during the procedure were night pain and capsulitis ($n = 6$), joint reduction incomplete ($n = 8$) due to soft tissue interposition, failed or torn ligament ($n = 2$) which could possibly be due to the sharp lateral edge of the corocoid or non-anatomic clavicular tunnel placement, migration of sleeve ($n = 1$) due to weak bone at the lateral end of clavicle, neuropraxia ($n = 1$) and fracture clavicle ($n = 1$) due to multiple entry point for the clavicular tunnels.

The night pain and capsulitis all resolved by medical management. The problem related to the reduction of the joint was due to soft tissue interposition especially in chronic RW type IV injuries. In the case where the sleeve migrated due to weak bone, the procedure was salvaged by converting the technique to open surgery. The case of fracture clavicle was salvaged by adding LCP to treat the fracture. However, at the latest follow-up, both the patients have done well. The UCLA score for 22 acute RW type III injuries was 17 excellent, 2 good and 3 fair, and in 15 chronic RW type III, there were 13 excellent and 2 good results, respectively. The UCLA score in the 6 cases of acute RW type IV was 3 excellent, good in 1 and poor in 2 cases. In 11 chronic RW type IV, the UCLA score was 7 excellent, 3 good and 1 fair result. The overall results for the acute injury out of 28 was 20 excellent, 3 good, 3 fair and 2 poor, and out of 26 chronic injury, it was 20 excellent, 5 good and 1 fair result on the UCLA-modified AC scale, respectively. The Weaver–Dunn procedure for chronic RW type III injury was excellent in all 8 cases, and there were 5 excellent, 2 good and 1 fair result in chronic RW type IV injury. There was one excellent and one good result in the distal clavicle resection cases. The SSV in acute RW injury improved from 38.5% pre-operatively to 91.7% post-operatively, while in RW type IV injuries, the pre-operative value of 30% improved to 82.5% post-operatively. However, when cases ($n = 16$) who underwent Weaver–Dunn procedure were compared to cases ($n = 10$) not undergoing the procedure, no significant difference was

found, probably because of less number of cases and more not so good results with Weaver and Dunn procedure.

The statistical analysis was done using SPSS software version 17 to evaluate the results. The Wilcoxon signed-rank test was used to test the significance of difference in the mean pre-operative and post-operative SSV scores. A statistically significant difference ($P = 0.001$) was observed between the pre-operative and post-operative scores in all patients. While the type of injury did not influence the mean difference, it could be seen that in cases with acute injuries and immediate reconstruction, there is a relatively large significant difference post-operatively ($P = 0.001$). However, the UCLA scores analysed by using Mann–Whitney U test between and across groups did not show any significant results.

Discussion

The AC joint separation is the most common injury accounting for 9% of all shoulder girdle injuries [24]. In Sweden, the incidence of AC joint dislocation regardless of the degree in the age group of 15–64 years is 18/100,000 for men and 1/100,000 for women [26]. Different classification systems are in use for AC joint dislocation like Allman, Tossy and the most widely accepted the Rockwood type, which was used here to identify the injuries [27].

Plain radiographs are thought to be less accurate while evaluating the degree of subluxation especially RW type IV injury [4]. There is also an inverse correlation found between the craniocaudal dislocation and Constant score while analysing the AC joint dislocation by 3D-CT scan [2]. However, we relied on more of intraoperative control for joint reduction and functional outcome for evaluating this injury. Also in most cases, the coracoclavicular distance was within 3–5 mm.

The coracoclavicular sling surgery is known to fare badly due to abrasive wear of the reconstructed ligament under the corocoid process or due to slippage of the graft. In a comparison of synthetic grafts, the load to failure of braided PDS was found to be better than fibre wire or merselene tape. However, in the techniques for AC joint reconstruction where the grafts are used through the tunnels in the clavicle and corocoid have been found to be more anatomic, with less abrasive wear and good outcome [19, 34].

There is no clear consensus on the distal clavicle excision (DCE) in the literature. The AC joint is not a pain generator, and any excess mobility in the antero-posterior direction at the AC joint will lead to clinical failure of DCE and AC joint reconstruction. In cases where the DCE was not done and the AC joint was

preserved, there was no arthrosis found, and also in cases where DCE was done, no significant improvement in the outcome was noticed [5, 6].

The coracoacromial (CA) ligament (246 ± 69 N) is not of adequate strength to replace the coracoclavicular (CC) ligaments (621 ± 209 N) [8]. The addition of CA ligament transfer to distal clavicle in AC joint reconstruction with hamstring allograft did not significantly improve the overall biomechanical strength [8]. Although the Weaver–Dunn–Chuinard procedure (CA ligament with a bone piece) with double-button fixation of the chronic AC joint dislocation gave encouraging results, the durability of the reconstruction in a series of 10 cases was unproven [20]. The residual subluxation and dislocation in spite of various Weaver–Dunn procedures for AC joint dislocation are reported to be between 29 and 76% [28, 32]. The CA ligament transfer was not consistently done in all patients in our series and in whom it was done showed excellent result in chronic RW type III injuries and mixed result in chronic RW type IV injuries on the UCLA-modified AC rating scale.

Most failures of the CC ligament reconstruction occur in the first 6 weeks of the reconstruction [20]. In some cases, the mode of failure of the reconstructed graft is through the mid-substance (44%), or through the fracture of the corocoid, and in some it is not clear [8, 9, 23–25]. In some instances, it has been advised to add an additional cerclage suture of high strength around the clavicle and the corocoid to improve the ultimate load to failure and the stiffness of the reconstructed ligament and transfer the mode of failure from the graft to the bone [8]. In this series also, the ligament was found to be torn in mid-substance (2 patients), and one each fracture of clavicle and migration of sleeve was seen respectively.

A rigid fixation of the AC joint or the clavicle to the corocoid will alter the biomechanics of the AC joint complex increasing joint pressure, reducing mobility, pain and ultimately poor outcome of the procedure [4, 18]. Partial loss of joint reduction did not influence the overall outcome but complete loss of reduction in AC joint reconstruction lead to worse results [32]. Anatomic reduction is not absolutely necessary for good functional outcome because even an elongated reconstructed ligament in AC joint disruption is thought to provide enough stability to the clavicle to reduce the symptoms and improve the function [30]. Hence, it is important to assess the reducibility of the dislocated AC joint before surgery to decide on only CC ligament reconstruction or addition of Weaver–Dunn procedure to CC ligament reconstruction in case of irreducibility of AC joint.

The success rate reported in the literature for AC joint surgery in both acute and chronic cases is around 90%, and in late reconstruction, it is around 78% [15, 22, 32]. In our

series also, the good to excellent results were 88%, and the fair to poor results were 11%.

Our series describes an all-arthroscopic technique of anatomic reconstruction of CC ligaments with a synthetic graft without violating the rotator interval and delto-trapezial attachments. There were also no instances of haematoma or infection in our series. The criticism of our series could be to have longer follow-up of patients, to also have normal distribution with uniform data for both the acute and chronic AC dislocation so as to assess the results in a better way and the technical difficulty of the procedure for less experienced surgeons. We also need to sincerely look at reducing the rate of adverse events.

Conclusion

The use of a synthetic ligament gives a safe and viable option for reconstruction of CC ligaments in AC joint dislocation. During the treatment of the AC joint dislocation by experienced surgeons, one can hope to achieve, with less soft tissue dissection good to excellent results that are comparable to open reconstructive procedures. However, separate long-term results of treating acute and chronic AC joint injuries are awaited.

Conflict of interest The authors declare that they have no conflict of interest.

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