



## Midterm outcome after AC Tightrope fixation

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**The purpose of our study was to evaluate the clinical and radiological outcome after a single AC TightRope® fixation in patients with an acute Rockwood type III-VI AC joint dislocation.**

We performed a retrospective cohort study of patients who underwent AC TightRope® fixation for an acute Rockwood type III-VI AC joint dislocation. During follow-up functional outcome was assessed using the Constant Murley Score (CS) and the UCLA Shoulder Rating Scale. A standard anteroposterior x-ray of both the operated and the contralateral shoulder was performed. The coracoclavicular (CC) distance was measured and compared with the day 1 postoperative x-ray.

Twenty-nine patients participated the study. Mean follow-up time after surgery was 43,4 months. Clinically the results were excellent : The mean CS was 91, the mean UCLA score was 33. Radiologically a mean loss of reduction of 3.2mm was seen. Following radiological findings were seen : Clavicular tunnel widening, coracoclavicular calcifications, and osteolysis at the clavicular button site.

Patients treated with a mini-open single AC TightRope® fixation had excellent midterm functional outcomes.

**Keywords :** AC luxation.

### INTRODUCTION

Acromioclavicular (AC) joint dislocation results from a direct fall on the shoulder, typically during sporting activities or bicycle accidents in the young

adult. Generally, the Rockwood classification (grade I-VI) is used to grade AC dislocation (10). Multiple surgical procedures exist for the treatment of high-grade AC dislocations. Currently, the two modern techniques that are widely used include hook plate fixation and coracoclavicular (CC) suspension technique using a flip button suspensory loop device such as TightRope® (1,2,7). The AC TightRope® fixation technique (Arthrex, Naples, Florida, USA), introduced as a simple, reproducible and minimally invasive technique, has gained popularity since its introduction 10 years ago. The results of the first reports were promising and this technique has excellent reported clinical outcomes for the treatment of acute Rockwood type III-VI AC joint dislocations.

To our knowledge only shortterm clinical or radiological follow-up results have been reported for this technique. The purpose of our study was to evaluate the midterm clinical and radiological outcome after a mini-open AC TightRope® fixation in patients with an acute Rockwood type III-VI AC joint dislocation.

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## MATERIAL AND METHODS

From January 2011 to December 2016, 39 patients with a Rockwood type III or V acute AC dislocation were operated with a single TightRope® (Arthrex, Naples, Florida, USA) fixation. Patients with associated injuries or chronic AC dislocations were excluded. In January 2017, 39 included patients were informed by letter and contacted by telephone to arrange a follow-up. Twenty-nine patients responded positively. The 10 drop outs were because of following reasons : 8 unreachable, 1 too busy with his work and 1 removal of the TightRope® because of superficial infection. During follow-up functional outcome was assessed and a bilateral standard anterior-posterior (AP) shoulder x-ray was made. All patients signed an informed consent.

To assess the functional outcome the Constant Murley Score (CS) and the UCLA Shoulder Rating Scale were used.

For the radiological assessment the CC distance was measured on 4 different x-rays per patient : a standard anteroposterior x-ray of the shoulder (1) before surgery, (2) after surgery, (3) during follow-up and (4) on the contralateral side was used. Radiological complications as clavicular tunnel widening, coracoclavicular calcifications and osteolysis at the clavicular button site were also evaluated.

All statistical analyses were performed using SPSS Version 20.0 (SPSS Inc, Chicago, IL, USA).

### Operative procedure : mini-open single AC TightRope® fixation

The patient was positioned in the beach chair under general anaesthesia. A +/- 4cm skin incision was made vertically from the coracoid process towards the distal part of the clavicle. A blunt dissection of the subcutis and the trapezius muscle was performed in order to visualise the upper side of the distal clavicle and the AC joint. Using a power tool, a 2.4 mm guide pin was vertically drilled in the middle of the upper surface of the distal clavicle. A tunnel through the clavicle was made overdrilling the guide pin with a 4 mm cannulated drill. Secondly the upper part of the coracoid process was visualised by

blunt dissection through the deltopectoral interval. In a similar way a second tunnel was made with a 4 mm cannulated drill in the middle of the coracoid process. Meanwhile the surrounding tissues were protected with 2 little Hohmann retractors medial and lateral from the coracoid.

The oblong button of the TightRope® fixation device was passed through the clavicle with an 18" Nitinol Suture Passing Wire (Arthrex, Naples, Florida, USA). Next, the button was pushed in the second tunnel with a needle holder, pushed through the tunnel with the blunt side of the 2.4mm guide pin and flipped to a horizontal position under the coracoid process. In order to assure the correct position of the button, the Fiber Wire part of the TightRope® between the 2 buttons was pulled back firmly. Subsequently pushing the clavicle inferiorly and slightly anteriorly reduced the AC dislocation. The incision enabled a visual control of the AC joint. The round button was tensioned against the clavicle. The Fiber Wires were knotted in order to avoid secondary loosening of the tension. The knot was flattened and covered by soft tissue of the deltotrapezial fascia in order to avoid a prominent palpable mass at the collarbone.

## RESULTS

The majority, 26 patients, of the total study populations (n=29) was male. The mean age was 42.3 (range, 19-69) years. The mean follow-up time was  $43.4 \text{ months} \pm 20.8$  (range, 15 to 72). In 66.7% of the cases the dominant side was operated. The mechanisms of injury were : a bicycle accident (n=14), a sports injury (n=8), a direct fall on the shoulder (n=6), or a car accident (n=1).

At latest follow-up, the mean CS was  $91 \pm 5.9$  (range, 81 to 100). The mean UCLA shoulder rating scale was  $33 \pm 1.9$  (range, 29-35). All patients returned to work and 93.4% was able to resume their sporting activities. In one case a revision was needed because of total loss of reduction. As mentioned before, in another case, removal of the TightRope® was necessary because of infection of the material. This patient was not included in this study.

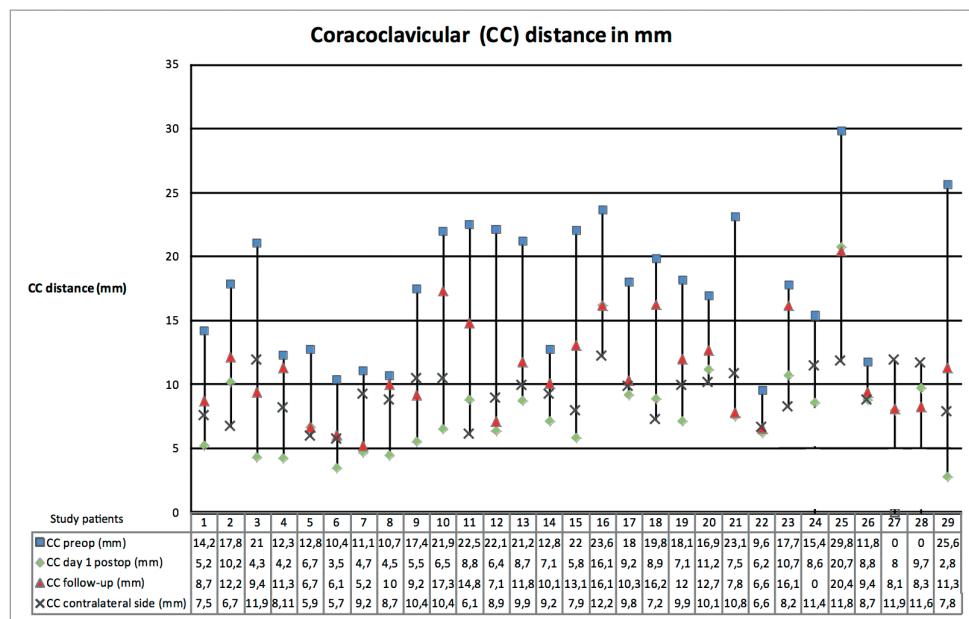


Figure 1. — Coracoclavicular distance

The mean CC distance preoperative, at day 1 postoperative and at follow-up were respectively  $17.7 \pm 6.8$  mm (range, 10.4-29.8),  $7.8 \pm 3.6$  mm (range, 2.8-20.7) and  $11.0 \pm 3.7$  mm (range, 5.2-20.4). The contralateral shoulder was used as a healthy reference. The mean CC distance on the contralateral side was  $9.1 \pm 6.8$  mm (range, 5.7-12.2).

We were able to calculate the height of the dislocation using the CC distance of the contralateral shoulder. The height of dislocation is visualised in figure 1 as the distance between the square and the triangle.

Partial loss in reduction was seen in the follow-up x-ray (figure 1). The mean difference in CC distance between the day 1 postoperative x-ray and the follow-up x-ray was 3.2 mm. In figure 1 this is visualized as the distance between the rhombus and the triangle.

Given the contralateral side as the healthy reference, a little overcorrection was seen after surgery. The mean difference in CC distance between the day 1 postoperative x-ray and the contralateral healthy side x-ray is a negative value :  $-1.3 \pm 3.5$  mm. This is visualised in figure 1 as the distance between the rhombus and the cross.

The following radiological complications were seen : Clavicular tunnel widening in 34.5% (n=10),



Figure 2. — Radiological complications.



Figure 2A. — Clavicular tunnel widening



**Figure 2B.** — Coraco-clavicular calcifications.



**Figure 2C.** — Osteolysis at the clavicular button.

coracoclavicular calcifications in 37.9% (n=11), and osteolysis at the clavicular button site in 31.0% (n=9). (Figure 2)

## DISCUSSION

Multiple different operation techniques are used for the management of AC joint dislocations.

To our knowledge, this is the first study that reports the functional and radiological outcome after a single mini-open AC TightRope® fixation in patients with acute, Rockwood grade III-VI, AC joint dislocation with a mean follow-up of more than three years. Functional outcome of our patients was excellent.

The last 10 years, the AC TightRope® fixation technique has gained popularity. Excellent clinical outcomes have been reported in similar studies, using a single AC Tightrope® fixation. They are listed in table 1. The mean follow-up time in these studies was between 12 and 31 months.

Initial reports regarding the Tightrope® fixation focused on clinical outcome. Despite the reported excellent functional outcome, less emphasis was put on the radiological findings. More recently, reports mention the complications of similar CC ligament fixation techniques. Loss of reduction is the most frequent finding (11,13).

Reports, regarding the single AC Tightrope® fixation technique, with a specific radiological outcome are summarized in table 2 and table 3. The

Table I. — Literature overview of functional outcome

Study	No. of patients	Mean follow-up time (months)	Scoring system	Score
Our study	29	43.3	Mean CS:	91 ± 5.9 (range, 81 to 100)
			Mean UCLA score:	33 ± 1.9 (range, 29-35)
Spoliti et al. (12) 2014	19	12	Mean CS:	89.7
El Sallakh (8) 2012	10	24	Mean CS:	96.3 (range, 94-99)
Defoort et al. (6) 2010	16	17	Mean DASH score:	2.29 (range, 0-5.83)
			Mean VAS score:	0.8 (range 0-2)
Flinkkila et al. (9) 2014	56	31	Mean CS (SD):	88 (10)
			Mean DASH (SD):	9 (9)
Chaudhary et al. (3) 2015	17	22.1	Mean CS:	86.4 (range, 63-96)
Darabos et al. (5) 2015	34	6	Mean CS:	92
			Mean DASH:	6.64

Table II. — Literature overview of pre- and postoperative CC distance

Study	Mean CC Distance		
	Preoperative	Postoperative	At Follow-up (period)
Our study	17.7 mm	7.8 mm	11.0mm
Flinkkila et al.(9) 2014	22 mm	11 mm	17 mm
Chaudhary et al.(3) 2015	21.5mm	/	10 mm (1year)
Darabos et al. (5) 2015	26.9 mm	7.0 mm	15.7 mm (6 months)
Cohen et al.(4) 2011	/	37 mm	38.2 mm (1 year)
Zhang et al.(14) 2017	21 mm	11.4 mm	/
Shin et al.(11) 2015	16.1mm	10.5 mm	13.7 mm

Table III. — Radiologic Findings

	Radiological findings
<b>Our study (n=29)</b>	Clavicular tunnel widening (n=10) Periarticular calcifications (n=11) Osteolysis at the clavicular button site (n=9) > 5 mm CC difference at follow-up (n=8) Recurrence of dislocation (n=5)
<b>Spoliti et al.(12) 2014 (n=19)</b>	Partial loss of reduction (n=2) Total loss of reduction (n =1)
<b>El Sallakh (8) 2012 (n=10)</b>	Displacement of the AC joint (n=0)
<b>Defoort et al.(6) 2010 (n=16)</b>	'Erosion of the upper part of the clavicular' (n=4) Recurrent subluxation (<1cm) (n=5) Redislocation (>1cm) (n=1)
<b>Flinkkila et al. (9) 2014 (n=56)</b>	'Migration of the of the clavicle-side button' (n=4) CC difference at follow-up 0-5mm (n=16) CC difference 6-10mm (n=16) CC difference >10mm (n=6) At the 6-week follow-up: failure of fixation in 9 patients, well maintained reduction 47 patients
<b>Chaudhary et al.(3) 2015 (n=17)</b>	Partial loss of reduction due to osteolysis at the clavicular button site (n=2)
<b>Darabos et al. (5) 2015 (n=34)</b>	Recurrence of dislocation (n=2)
<b>Cohen et al. (4) 2011 (n=16)</b>	Recurrences of dislocation (n=3)
<b>Zhang et al. (14) 2017 (n=24)</b>	Partial loss of reduction: (n=4) Failure: (n=2)
<b>Shin et al. (11) 2015 (n=18)</b>	Reduction loss 50%-100% (n=4) Reduction loss > 100% (n=2) Clavicular bony erosions (n=3)

most relevant radiological outcome parameter is the CC distance. In the majority of these studies there is an important difference between the CC distance postoperative and at follow-up (table 2). Most radiological findings emphasize the loss of reduction at follow-up (table 3). In our study, analysis of radiological outcome parameters also revealed a loss of reduction. The mean loss of reduction in CC distance was 3.2 mm. In 8 cases, the loss of reduction was more than 5mm. These outcome parameters are comparable with the current literature reports.

Using the absolute value of the CC distance to compare different studies is not advisable. As seen in table 2, there is an important difference in the absolute values of the CC distance between the different studies. This difference has two causes. Firstly, the radiological protocol can vary between the studies. This protocol determines the inclination of the x-rays, the centring point and the position of the patient. A little change in one of these factors results in a different image, and thus a different CC distance. Secondly, the exact reference points

to measure the CC distance can differ between the studies. In most studies, including this study, the reference points are the undersurface of the clavicle and the upper border of the coracoid process. In the study of Cohen et al. the buttons of the TightRope® device were used as reference points. This explains the remarkable higher values of CC distance in their study (4). Because of this variability it is less relevant to use the absolute value of the CC distance to compare different studies. For the interpretation of radiological outcomes we focused on the difference in CC distance pre- and post-operative and the difference in CC distance with the contralateral healthy shoulder in the same patient.

Further analysis of the radiographs revealed remarkable findings such as clavicular tunnel widening, periarticular calcifications and osteolysis at the button site in 10, 11 and 9 cases respectively. Osteolysis at the button site was described in other studies as ‘erodation of the upper part of the clavica’, ‘clavicular bony erosions’ or ‘migration of the clavicle-side button’ (3,6,9,11). The radiological findings had no functional implications in our patients. As the Tightrope® replaces the CC ligaments, the device remains in situ lifelong. We cannot predict if the initial clavicular tunnel widening and button site osteolysis will lead eventually to clavicular breakout of the button.

Given the fact that the device remains in the body and the population is young, studies with a longer follow-up time are needed to find out if these radiological findings predict future functional implications.

The weakness of this study is its retrospective design.

The strength of this study is the long follow-up time. We can conclude that this technique results in excellent midterm functional outcomes and not only in excellent short-term results. The mean follow-up time was 43.4 months. Some radiological findings, such as, tunnel widening and periarticular calcifications, wouldn’t be apparent in a short-term postoperative radiograph.

## CONCLUSION

Patients treated with a mini-open single AC TightRope® fixation had excellent midterm func-

tional outcomes. Some loss of reduction was seen radiographically. Midterm postoperative radiographs frequently revealed osteolysis at clavicular button site, clavicular tunnel widening and calcifications. Until now these radiological findings had no functional implications.

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