Hook plate versus tightrope for acute grade III acromioclavicular dislocation

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Introduction
The different surgical techniques described to treat type III acromioclavicular (AC) dislocation illustrate the fact that the ideal surgery remains controversial. This study aims at comparing two familiar different methods of stabilization of this injury.
Patients and methods
Between May 2013 and February 2015, 20 patients with acute Rockwood type III AC dislocation were divided into two groups, to compare the functional outcome after using either hook plate or tightrope stabilization. Patients were evaluated using the University of California Los Angeles Shoulder Scoring System.
Results
Nine patients in the hook plate group were reoperated to remove the device, except one who refused to be reoperated. Only one patient in the tightrope group had revision because of rupture of the tightrope in the fourth week with successful and good outcome. The patients of the hook plate group showed significantly higher incidence of complication in comparison with the tightrope group (40 vs. 10%, respectively). Two (20%) cases in the hook plate group suffered from superficial infection and another two (20%) cases showed signs of osteolysis in 1-year follow-up plain radiographs. There was insignificant difference between both groups regarding severity of pain. The majority (70%) of the tightrope patients regained their normal functional activities, whereas only 40% of the hook plate patients did ($P<0.001$). About half (50%) of the tightrope group in comparison with 30% of hook plate group had active forward flexion more than 150° ($P<0.01$). Both groups showed no significant differences regarding the degree of muscle strength, patients' satisfaction, and total outcome of the University of California Los Angeles score ($P>0.05$).
Conclusion
Open reduction and stabilization with either hook plate or tightrope in type III AC dislocations are effective techniques regarding the objective outcome scores, with no significant differences between the two groups. However, tightrope fixation provides a low rate of failure and complications and avoids the need for second surgery to remove the implant.

Keywords:
acromioclavicular, dislocation, hook plate, tightrope

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Introduction

Grade III acromioclavicular (AC) dislocation involves complete loss of contact between the clavicle and acromion secondary to total disruption of both the AC and coracoclavicular ligaments, with loss of vertical and horizontal stability [1]. Early surgical repair for grade III AC dislocations results in better outcome. Surgical treatment enables restoration of AC joint anatomy [2].

The different surgical techniques described to treat AC dislocation illustrate the fact that the ideal surgery remains controversial. The use of metal implants can be complicated by displacement of these implants. Muscle transfers dynamically pull the clavicle downward through the action of the coracobrachialis and the biceps muscles. However, the problem is sagging of upper limb and not a high-riding clavicle. Furthermore, these procedures carry significant chance of injury to the musculocutaneous nerve, failure of the coracoid to heal to the clavicle, or loss of screw fixation or screw breakage [3–5].

The hook plate is effective for fixation of grade III AC dislocations [6,7]. However, it can cause disturbances over the subacromial bursa, supraspinatus tendinitis, disturbances over the plate end, acromial osteolysis, and migration of the osteosynthesis material [8]. Postoperative complaints of shoulder pain and limited shoulder motions are frequent. For this, it is recommended to remove the hook plate after healing

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to prevent potential irritation of the acromion or impingement of the rotator cuff [9].

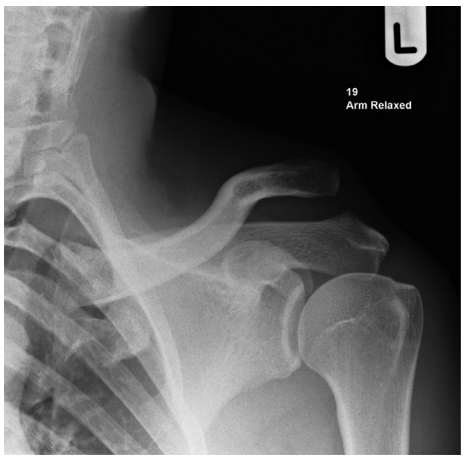
On the other hand, tightropes apply a nonrigid fixation of the AC joint that maintains reduction, allowing for normal movement at the joint. They withstand cyclic loading without cutting out from the bone, and there is no need for removal of implant [10].

Patients and methods

During the period from May 2013 to February 2015, 20 patients with acute Rockwood type III AC dislocation (Fig. 1) were randomly divided into two groups in this comparative interventional study, including 15 men and five women; the mean age was 35.2±8.2 (age range: 22–52) years.

All the patients were injured for less than 3 weeks. Chronic dislocations, open injuries, or associated fractures of the clavicle or coracoid were excluded from the study. Ten patients in the first group had open reduction and hook plate fixation (Fig. 2). Nine of them had the hook plate removed within 6–8 months after the surgery, whereas the last one refused to do a second operation. The other 10 patients in the secondgroup had also open reduction but were stabilized with the tightrope (Arthrex) system consisting of number 5 fiber-wire suture with two metallic buttons, one circular and one oblong, which were held against the cortices of the clavicle and the coracoid (Fig. 3). In all, 14 of them presented because of road traffic accidents [hook plate (n=8) and tightrope (n=6)] and the other six presented because of falling [hook plate (n=2) and tightrope (n=4)]. Right-sided injury was present in seven cases of hook plate versus five cases of tightrope.

Figure 1



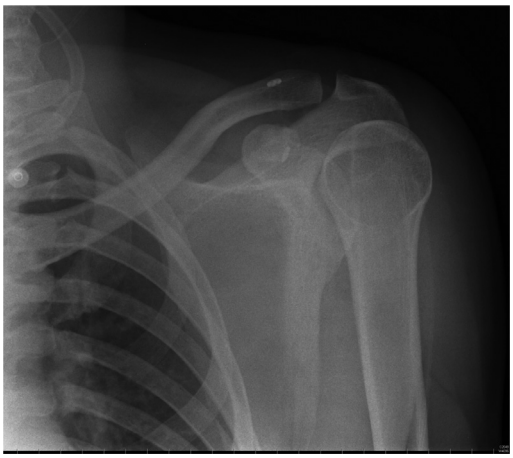
Acromioclavicular disruption grade III.

Preoperatively, anteroposterior and axillary radiographs were performed for all patients to assess the severity of the dislocation and any associated fracture.

Under general anesthesia, in beach chair position, with the arm wrapped freely movable beside, a curved incision was used to expose the distal clavicle to the acromion. The skin was elevated in full-thickness flab. Any articular cartilage debris in the joint was removed. The arm and the scapula were elevated toward the clavicle to reduce the dislocation. Temporary fixation using transacromial K-wire was sometimes needed to hold the reduction.

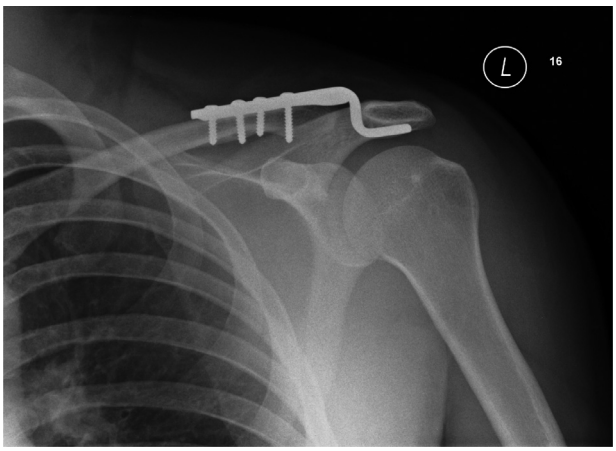
In the first group (10 patients), little fibers of the trapezius were detached from the medial border of the acromion just dorsal to the AC joint for passage of the hook under the acromion. The hook of the plate was inserted into the bottom of the acromion as

Figure 2



Acromioclavicular disruption repaired by tightrope.

Figure 3



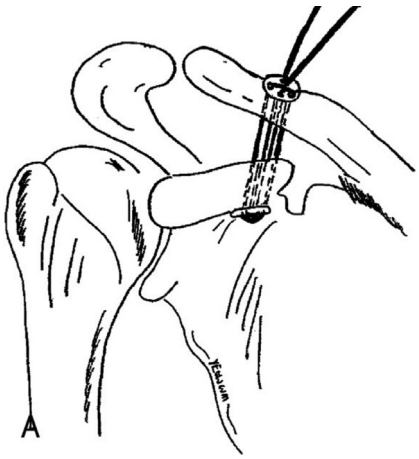
Acromioclavicular disruption repaired by hook plate.

posterior as feasible to ensure complete attachment to the acromion and to avoid subacromial impingement, and the proximal end of the plate was screwed into the clavicle by 3.5 mm cortical or 4 mm cancellous screws. Range of shoulder motion was checked, ensuring that no impingement of head over the hook occurs in abduction or external rotation.

In the other group (10 patients), the fascia was opened transversely. The deltoid is cut off the clavicle subperiosteally, allowing visualization of the coracoid process. The base of the coracoid was then exposed and identified well. A 2.5-mm drill bit was positioned on the superior aspect of the clavicle directly straight over the coracoid to drill down the four cortices of the clavicle and the coracoid, centered on both as possible to achieve strongest fixation and avoid coracoid iatrogenic fracture. The guide wire attached to the fiber-wire suture of tightrope is passed through the clavicle and then the coracoid and retrieved below the coracoid. The oval button should be placed perpendicular to the line of the suture and directly opposite to the undersurface of the coracoid process, whereas the round superior button should lay flat on the superior surface of the clavicle. Traction was then placed on the two free ends of the sutures above the clavicle, closing the interval between the two buttons and pulling the clavicle down onto the coracoid process. Both ends of the suture were then alternately tightened until the superior button fitted snugly on the clavicle to achieve anatomical reduction of acromioclavicular joint (ACJ) allowing physiological motion (Fig. 4).

For both groups, radiograph was used to confirm the reduction of the dislocation and then nonabsorbable suture was used to repair the conoid and trapezoid ligaments if possible; the superior part of the AC ligament, trapezius–deltoid fascia, and ACJ capsule were sutured; and the incision was closed.

Figure 4



Technique of tightrope application.

Postoperative arm pouch sling with immobilizer was applied for 6 weeks with passive exercises allowed after 1 week and active assisted exercises allowed at 6 weeks. Full active shoulder movement was started as pain allowed.

Shoulder anteroposterior radiograph was taken postoperatively, after 3 months, and 6 months after the surgery. In the first group, radiographs were also taken before the removal of the hook plate to study the subacromial osteolysis or osteoarthritis of the ACJ, whereas in the second group as the tightrope can withstand cyclic loading without cutting out from the bone and because it was relatively low-profile there was no need for removal of implant. Another radiograph was taken after 1 year (or at the end of follow-up) to check any subluxation or arthritis in the joint in both groups. By that time, the hook plate had been removed from all patients in the first group (except one patient refused to remove it).

For the clinical and functional objective evaluation, the University of California Los Angeles Shoulder Rating Scale (UCLA) was used at 1 year, which analyzes pain (1–10), function (1–10), active forward flexion (0–5), strength (0–5), and satisfaction (0 or 5) [11].

Results

The study included 20 patients who were equally divided into two groups (10 patients in each group). Demographic and injury characteristics of the studied patients in both groups were matched for mean age (35.3 vs. 35.1 years, respectively) and sex (female/male: 1/9 vs. 4/6, respectively) without significant differences. The mechanisms of injury for these patients' population were falling from a height [hook plate (n=2) and tightrope (n=4)] and road traffic accident [hook plate (n=8) and tightrope (n=6)]. Right-sided injury was present in seven cases of hook plate versus five cases of tightrope.

All patients were admitted for operation within 1 week of the onset of the injury with a mean delay time of 2.3 ±1.87 days. The follow-up time of the studied patients ranged from 6 to 15 months with a mean of 11.5±2.1 months. There were insignificant differences between both groups regarding delay and follow-up times. All cases in the hook plate group were reoperated to remove the device, except one case who refused to be reoperated. All cases of tightrope group did not perform any reoperative procedures, except one case

who had revision due to failure because of rupture of the tightrope in the fourth week. The revision of this patient was successful with good outcome. The patients of the hook plate group showed significantly higher incidence of complication in comparison with the tightrope group (40 vs. 10%, respectively). Two (20%) cases in the hook plate group suffered from infection, which was superficial and needed only dressing. Another two (20%) cases showed signs of osteolysis in 1-year follow-up plain radiographs (Table 1).

Outcome characteristics of the studied patients are shown in Table 2. There was insignificant difference between both groups regarding severity of pain postoperatively. Both groups show no pain in most of the cases, with only slight pain in about 40% of the studied patients. The majority (70%) of the tightrope patients regained their normal functional activities, whereas only 40% of the hook plate patients did ($P<0.001$). About half (50%) of the tightrope group in comparison with 30% of the hook plate group had active forward flexion more than 150° ($P<0.01$). Both groups show comparable results, without significant differences, regarding the degree of muscle strength, patients' satisfaction, and total outcome of UCLA score ($P>0.05$).

Discussion

AC dislocation is common; ~20% of shoulder injuries involve AC joint dislocations. AC dislocations can be classified into six grades according to the extent of displacement of the clavicle in relation to the acromion [1].

Early surgical repair for grade III AC dislocations results in better outcome and faster return to normal activities [2], although conservative treatment is also recommended [5]. Surgical treatment enables restoration of AC joint anatomy, but there may be complications associated with the metallic device such as breakage and/or migration of the pins. Although conservative treatment does not restore the anatomy of the joint, it enables early rehabilitation [12].

In our study, hook plate patients show good results regarding the degree of muscle strength, patients' satisfaction, and total outcome of UCLA score. Generally, the hook plate is an easy and effective technique for fixation of grade III AC dislocations [6,13], but few techniques can achieve satisfactory results [1].

The technique is simple, only basic instruments are needed, and every surgeon on duty with experience of basic fracture surgery can successfully fix these injuries with a hook plate. However, the presence of the hook in the subacromial space may have adverse effects and easily leads to pain and shoulder joint stiffness that subsides slowly [14,15]. Osteoarthritis and osteolysis are the two common complications after hook plate use, which are associated with the impairment of shoulder function [16]. Hook plates can cause disturbances over the subacromial bursa, supraspinatus tendinitis, disturbances over the plate end,

Table 1 Operative characteristics of the studied patients (n=20)

Variables	Hook plate (n=10)	Tightrope (n=10)	Test	P-value
Delay time (days)				
Mean±SD	2.2±1.8	2.8±1.4	t=1.1	0.29
Range	0–7	1–6		
Follow-up (months)				
Mean±SD	11.7±1.57	11.3±2.58	t=0.38	0.71
Range	6–15	9–14		
Reoperation [n (%)]				
No	1 (10.0)	9 (90.0)	Fisher	0.0001**
Refused	1 (10.0)	0 (0.0)		
Removed	9 (90.0)	0 (0.0)		
Revision	0 (0.0)	1 (10.0)		
Time to reoperation	(n=9)	(n=1)		
Mean±SD	6.4±0.73	2.0±0.0	–	–
Range	6–8	2		
Complications [n (%)]				
No	6 (60.0)	9 (90.0)	χ^2=24	0.0001**
Failure	0 (0.0)	1 (10.0)		
Infection	2 (20.0)	0 (0.0)		
Osteolysis	2 (20.0)	0 (0.0)		

*$P<0.05$, significant. **$P<0.01$, highly significant.

Table 2 Outcome characteristics of the studied patients (*n*=20)

Variables	Hook plate (*n*=10)	Tightrope (*n*=10)	Test	*P*-value
Pain				
Occasional and slight [*n* (%)]	4 (40.0)	4 (40.0)	Fisher	1.00
None [*n* (%)]	6 (60.0)	6 (60.0)		
Mean±SD	9.2±1.03	9.3±1.0	t=0.43	0.68
Range	8–10	8–10		
Function				
Slight restriction only [*n* (%)]	6 (60.0)	3 (30.0)	χ^2=18.1	0.0001
Normal activities [*n* (%)]	4 (40.0)	7 (70.0)		
Mean±SD	8.8±1.03	9.56±0.88	t=2.5	0.035
Range	8–10	8–10		
Active forward flexion [*n* (%)]				
90°–120°	2 (20.0)	0 (0.0)	Fisher	0.47
120°–150°	5 (50.0)	5 (50.0)	χ^2=0.0	1.00
>150°	3 (30.0)	5 (50.0)	χ^2=8.3	0.0039
Strength				
Grade 4 [*n* (%)]	4 (40.0)	4 (40.0)	Fisher	1.00
Grade 5 [*n* (%)]	6 (60.0)	6 (60.0)		
Mean±SD	4.56±0.53	4.7±0.48	t=1.00	0.35
Range	4–5	4–5		
Patients' satisfaction [*n* (%)]				
Satisfied	10 (100.0)	10 (100.0)	Fisher	1.00
Not-satisfied	0 (0.0)	0 (0.0)		
Total University of California Los Angeles score				
Good [*n* (%)]	7 (70.0)	6 (60.0)	Fisher	1.00
Excellent [*n* (%)]	3 (30.0)	4 (40.0)		
Mean±SD	32.2±2.33	32.5±2.22	t=1.00	0.35
Range	28–35	29–35		

P>0.05, insignificant.

acromial osteolysis, and migration of the osteosynthesis material [8].

In this study, two (20%) cases in the hook plate group suffered from superficial infection, and another two (20%) cases showed signs of osteolysis in 1-year follow-up plain radiographs. This was in agreement with Chen *et al.* [9], who reported that postoperative radiograph imaging showed osteolysis in 10 (30.3%) cases, osteoarthritis in six (18.1%) cases, osteolysis associated with osteoarthritis in four (12.1%) cases, and steel hook broken in one (3%) case.

All hook plate patients were reoperated to remove the device, except one case who refused to be reoperated. Plate removal increased the reoperation rate of hook plate fixation substantially. In addition, plate removal is indicated after ligament healing, which prolongs recovery from the injury [16]. In contrast to hook plate, tightrope patients did not need the removal of the device. In addition, surgical reduction with tightrope could maintain the AC joint reduction during the first months and thereby enable biological healing, by working as an 'internal brace' that keeps the joint reduced during the necessary healing time [17].

In our study, only one case performs tightrope revision because of failure of the first operation. The revision shows successful results. Therefore, incidence of complications in the tightrope group was low (10%). Patients in the second group (tightrope) show grades 4–5 of muscle strength, 100% patients' satisfaction, and good to excellent outcome of UCLA score.

Tightrope technique allows visualization of the achieved reduction, which could explain the low complication rate. Tightrope fixations resulted in good outcome, good shoulder function, and normal quality of life [17,18].

In contrast to our study, Thiel *et al.* [19] and Defoort and Verborgt [20] studied 12 and 15 patients, respectively, and each reported fixation failure in one-third of the patients with grade III and V AC dislocations.

Similar to our data, El Sallakh [21] studied 10 patients and reported only one failure of fixation, which was the result of a technical error. Flinkkilä and Ihanainen [18] fixation failure rate was 16%. Scheibel *et al.* [22] and Salzmann *et al.* [4] studied 27 and 23 patients, respectively, who received double tightrope fixation

that was intended to fix and replace both conoid and trapezoid parts of coracoacromial ligament; early failures were rare but they reported slight losses of reduction at up to 6 months postoperatively, which did not affect clinical results. Patzer *et al.* [23] compared single and double tightrope fixation and found that early failures were more frequent when a single implant was used but late loss of reduction was similar in both groups. Functional results have been good in all previous studies.

Conclusion

Open reduction and stabilization with either hook plate or tightrope in type III AC dislocations are effective techniques regarding the objective outcome scores with no significant differences between the two groups. However, tightrope fixation provides a low rate of failure and complications and avoids the need for second surgery to remove the implant.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Gstettner C, Tauber M, Hitzl W, Resch H. Rockwood type III acromioclavicular dislocation: surgical versus conservative treatment. J Shoulder Elbow Surg 2008; 17:220–225.

2 Smith TO, Chester R, Pearse EO, Hing CB. Operative versus non-operative management following Rockwood grade III acromioclavicular separation: a meta-analysis of the current evidence base. J Orthop Traumatol 2011; 12:19–27.

3 Boileau P, Old J, Gastaud O, Brassart N, Roussanne Y. All-arthroscopic Weaver-Dunn-Chuinard procedure with double button fixation for chronic acromioclavicular joint dislocation. Arthroscopy 2010; 26:149–160.

4 Salzmann GM, Walz L, Buchmann S, Glabgly P, Venjakob A, Imhoff AB. Arthroscopically assisted 2-bundle anatomical reduction of acute acromioclavicular joint separations. Am J Sports Med 2010; 38:1179–1187.

5 Spencer EE Jr. Treatment of grade III acromioclavicular joint injuries: a systematic review. Clin Orthop Relat Res 2007; 455:38–44.

6 Kienast B, Thietje R, Queitsch C, Gille J, Schulz AP, Meiners J. Mid-term results after operative treatment of Rockwood grade III-V acromioclavicular joint dislocations with an AC-hook-plate. Eur J Med Res 2011; 16:52–56.

7 Steinbacher G, Sallent A, Seijas R, Boffa JM, Espinosa W, Cugat R. Clavicular hook plate for grade-III acromioclavicular dislocation. J Orthop Surg (Hong Kong) 2014; 22:329–332.

8 Tiren D, van Bemmel AJ, Swank DJ, van der Linden FM. Hook plate fixation of acute displaced lateral clavicle fractures: mid-term results and a brief literature overview. J Orthop Surg Res 2012; 7:2.

9 Chen C, Rong-Kui Q, Zhen H, Jiao Y. Effects of hook plate on shoulder function after treatment of acromioclavicular joint dislocation. Int J Clin Exp Med 2014; 7:2564–2570.

10 Lim Y, Sood A, Roger P, Gregory I. Acromioclavicular joint reduction, repair and reconstruction using metallic buttons V early results and complications. Tech Shoulder Elbow Surg 2007; 8:213–221.

11 Amstutz HC, Sew Hoy AL, Clarke IC. UCLA anatomic total shoulder arthroplasty. Clin Orthop Relat Res 1981; 155:7–20.

12 Larsen E, Bjerg-Nielsen A, Christensen P. Conservative or surgical treatment of acromioclavicular dislocation. A prospective, controlled, randomized study. J Bone Joint Surg Am 1986; 68:552–555.

13 De Baets T, Truijen J, Driesen R, Pittevils T. The treatment of acromioclavicular joint dislocation Tossy grade III with a clavicle hook plate. Acta Orthop Belg 2004; 70:515–519.

14 Chiang CL, Yang SW, Tsai SW, Kuen-Huang Chen C. Acromion osteolysis and fracture after hook plate fixation for acromioclavicular joint dislocation: a case report. J Shoulder Elbow Surg 2010; 19:e13–e15.

15 Stegeman SA, Nacak H, Huvenaars KH, Stijnen T, Krijnen P, Schipper IB. Surgical treatment of Neer type-II fractures of the distal clavicle: a meta-analysis. Acta Orthop 2013; 84:184–190.

16 Chen CH, Dong QR, Zhou RK, Zhen HQ, Jiao YJ. Effects of hook plate on shoulder function after treatment of acromioclavicular joint dislocationInt J Clin Exper Med 2014; 7:2564.

17 Flinkkilä T, Heikkilä A, Sirniö K, Pakarinen H. TightRope versus clavicular hook plate fixation for unstable distal clavicular fractures. Eur J Orthop Surg Traumatol 2015; 25:465–469.

18 Flinkkilä TE, Ihanainen E. Results of arthroscopy-assisted TightRope repair of acromioclavicular dislocations. Shoulder Elbow 2014; 6:18–22.

19 Thiel E, Mutnal A, Gilot GJ. Surgical outcome following arthroscopic fixation of acromioclavicular joint disruption with the Tightrope device. Orthopedics 2011; 34:e267–e274.

20 Defoort S, Verborgt O. Functional and radiological outcome after arthroscopic and open acromioclavicular stabilization using a double-button fixation system. Acta Orthop Belg 2010; 76:585–591.

21 El Sallakh SA. Evaluation of arthroscopic stabilization of acute acromioclavicular joint dislocation using the Tightrope system. Orthopedics 2012; 35:e18–e22.

22 Scheibel M, Droschel S, Gerhardt C, Kraus N. Arthroscopically assisted stabilization of acute high-grade acromioclavicular joint separations. Am J Sports Med 2011; 39:1507–1516.

23 Patzer T, Clauss C, Kühne CA, Ziring E, Efe T, Ruchholtz S, Mann D. Arthroscopically assisted reduction of acute acromioclavicular joint separations: comparison of clinical and radiological results of single versus double TightRope technique. Unfallchirurg 2013; 116:442–450.