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Failed suspension button acromioclavicular joint reconstruction revised with double-loop suture cerclage: a case report and review of the literature

Brett K. Jones, BS[a], Carson Fuller, MD[b], Christopher Kweon, MD[c,*]

[a]Washington State University Elson S. Floyd College of Medicine, Spokane WA, USA
[b]Department of Orthopaedic Surgery, Harbor-UCLA Medical Center, Torrance, CA, USA
[c]Department of Orthopaedics and Sports Medicine, University of Washington, Seattle, WA, USA

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Injury of the acromioclavicular (AC) joint accounts for approximately 12% of all shoulder injuries in the United States, with an estimated incidence of 1.8 per 10,000 people per year.[1,6] The AC joint is vital for the natural biomechanics of the upper extremity by providing multiaxis stability to the shoulder. Thus, trauma left untreated can leave patients in significant pain and discomfort.[10]

Among multiple classification systems for AC joint separations, the Rockwood classification system is commonly used, as only plain radiographs are needed to describe the degree of soft tissue involvement and joint dislocation.[4] Scores range from I-VI with increasing severity. General consensus exists that Rockwood types I-II should be managed conservatively, while Rockwood types IV-VI should be managed with surgical intervention.[20] Management of Rockwood type III injuries is still a topic of debate.[9,15]

In patients with AC injures who can benefit from surgical intervention, there is no consensus regarding optimal surgical treatment with more than 60 techniques still being reported on in literature.[7] However, most surgeons agree that addressing horizontal and vertical stability leads to optimal long-term patient outcomes.[1,14,22] Of the numerous surgical options available, the Twin-Tail TightRope (TTTR) (Arthrex, Naples, FL, USA), using an open operative approach to treat acute AC joint dislocation, has been shown to match the normal coracoclavicular (CC) ligament anatomy leading to acceptable horizontal and vertical AC joint stability.[3,4,22] Nevertheless, failure rates after AC joint repair range from 16.9%-25.2% as defined by recurrence of the AC joint dislocation.[11] If surgical complications persist, revision surgery may be necessary. However, AC joint instability due to bone loss at the clavicle and coracoid from previous bone tunnel placement, hardware removal, and inflammation from consecutive surgeries can lead to an increased complication rate.[2] Therefore, performing a revision surgery for the AC and/or CC joint requires the surgeon to tailor their surgical technique with the consideration of the primary surgery to adequately restore native joint biomechanics.

To our knowledge, there is a lack of literature describing the most appropriate salvage techniques for postoperative AC joint instability after failed suspension fixation devices used during the primary surgery. Here, we present a case report of a patient with AC/CC joint reconstruction using a TTTR and later revised with 2 FiberTape (Arthrex, Naples, FL, USA) cerclage loops. Additionally, we present a literature review of reported revision surgeries of the AC joint focusing on suspension device use.

Case presentation

This is an otherwise healthy 21-year-old male who presented to the emergency department after a fall from his bike over his handlebars, landing onto his right shoulder, resulting in the injury depicted in Fig. 1. The patient's injury was classified as a Rockwood type III AC joint separation. Due to the patient's desire to maintain

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*Corresponding author: Christopher Kweon, MD, Department of Orthopaedics and Sports Medicine, University of Washington, 3800 Montlake Blvd NE, Seattle, WA 98195, USA.

E-mail address: ckweon@uw.edu (C. Kweon).

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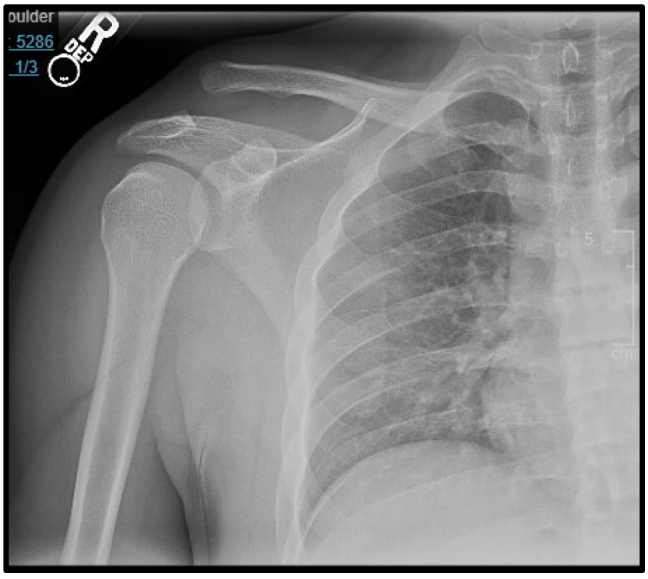

Figure 1 Preoperative anteroposterior (AP) view radiograph of a Rockwood type III AC joint dislocation of the patient's right shoulder. *AC*, acromioclavicular.

Figure 2 Postoperative AP view radiograph that shows near anatomical reduction of patient's right AC joint using TTTR device. Arrows are directed toward 2 clavicular buttons and 1 coracoid button. *AP*, anteroposterior; *AC*, acromioclavicular.

as much strength and function with overhead activity in the future, he elected to undergo AC/CC joint reconstruction.

Primary operation

One month after the initial injury, the patient was taken to the operating room for right shoulder surgery. Examination under anesthesia demonstrated full passive range of motion of the glenohumeral joint without instability. The AC joint was grossly unstable with the distal clavicle easily manipulated inferior to superior but not anterior to posterior. The distal clavicle was easily reduced to the acromion and stabilized using a single Arthrex TTTR device with button fixation through the base of the coracoid process and 2 limbs of heavy suture delivered through the clavicle reconstructing the anatomic structure of the conoid and trapezoid ligaments. Additional reinforcement was achieved by imbricating the redundant AC joint capsular tissue using high-tensile nonabsorbable suture after reduction of the AC joint. Postoperative films were taken, indicating near-good restoration and normal alignment of the previous Rockwood III AC joint separation (Fig. 2).

Postoperative rehabilitation instructions were given to the patient which consisted of sling and pendulum physical therapy exercises for the first 4 weeks, resumption of activities of daily living at 3 months, and swimming or jogging allowed at 3 months postoperation. Olympic-style lifting exercises could be resumed around the 5-6–month mark with resumption of full sports thereafter.

Reinjury

The patient returned 3 weeks after right shoulder open AC and CC joint reconstruction reporting that he denied pain; however, he felt the bump on his shoulder increasing in size. He denied any specific traumatic events but did report trying to swim in the first 2 weeks after surgery and discontinuation of sling use prior to the recommended 4 weeks of immobilization. He also reported accidentally dropping his laptop computer and subconsciously reached for it with his right arm while wearing his sling resulting in pain and discomfort. Fig. 3 shows radiographs of the right shoulder at 3 weeks postoperatively, demonstrating increased CC and AC distance with respect to prior examination (CC distance measures 16 mm, previously 9 mm; AC interval measures 8 mm, previously 3 mm). Nonoperative vs. operative management was discussed with the patient, and ultimately, he elected to undergo revision AC and CC joint reconstruction.

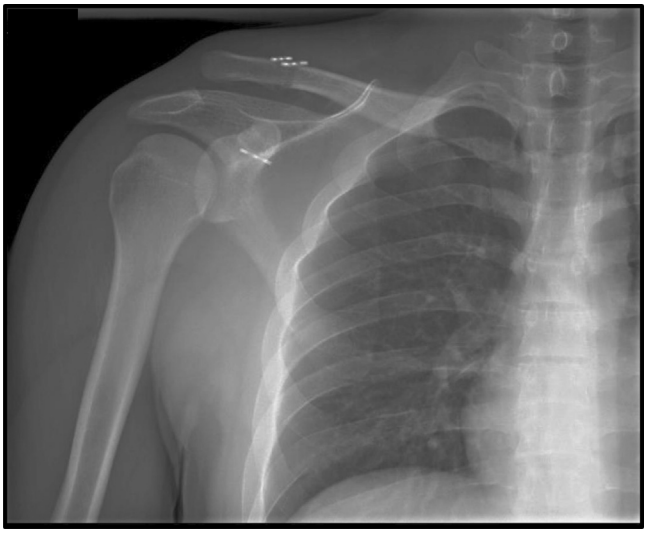

Figure 3 Postoperative, reinjury radiograph. Three-week postoperative AP view radiograph showing increased coracoclavicular distance and loss of reduction of the AC joint. *AP*, anteroposterior; *AC*, acromioclavicular.

Figure 5 Revision surgery with 2 looped Fiber Tape cerclages. Intraoperative photograph after TTTR device was removed and 2 FiberTape looped cerclages were put in place. Both cerclages travel inferiorly to form a complete loop around the coracoid process. *TTTR*, Twin-Tail TightRope (Arthrex, Naples, FL, USA).

Figure 4 Revision surgery and TTTR device failure. Intraoperative photograph showing displacement and loosening of proximal button and suture on TTTR device. *TTTR*, Twin-Tail TightRope (Arthrex, Naples, FL, USA).

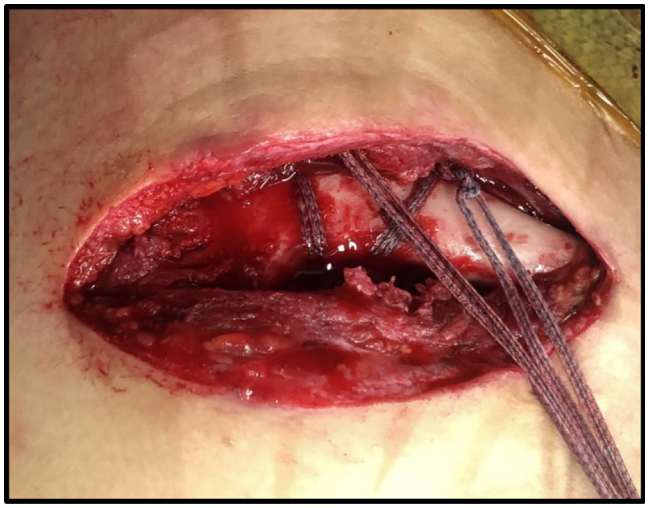

Figure 6 Placement of Fiber Tape cerclages on clavicle. Intraoperative photograph of close-up view portraying orientation of the 2 looped cerclages on patient's clavicle.

Revision surgery

Thirty one days after the initial operation, the patient was again taken to the operating room for revision AC and CC joint reconstruction (Figs. 4–6). Intraoperative findings showed maintained position of all 3 suspension buttons but loosening of the suture constructs of both the medial and lateral limbs. The medial limb was located approximately 40 mm from the distal clavicle and the lateral limb was 30 mm from the distal clavicle. The centrally placed drill hole through the base of the coracoid appeared in good position. There was slack in the suture material underneath the clavicle as well, consistent with failure of the suture material itself.

The entire TTTR system was removed, and revision fixation was performed using the Arthrex FiberTape cerclage system using 2 separate looped 4 mm FiberTape sutures. One was placed laterally corresponding to the trapezoid ligament and one was placed medially corresponding to the conoid ligament and both tensioned using the cerclage tensioning device. Radiographs were obtained intraoperatively to verify reduced position of the distal clavicle against the acromion. This was also stressed with the weight of the arm and traction pulled showing no change in position or reduction (Fig. 7).

Follow-up

At the 6-week follow-up visit postrevision fixation, radiographs of the right shoulder were obtained, demonstrating near-anatomic AC and CC joint alignment (Fig. 8). The patient reported minimal pain and tolerated gentle range of motion in flexion, extension, abduction, and internal and external rotation.

At the 1-year follow-up visit postrevision fixation, radiographs were obtained and showed adequate positioning of reduced AC joint and normal CC interval. Minimal heterotrophic ossification was observed around the surgical area surrounding the clavicle and

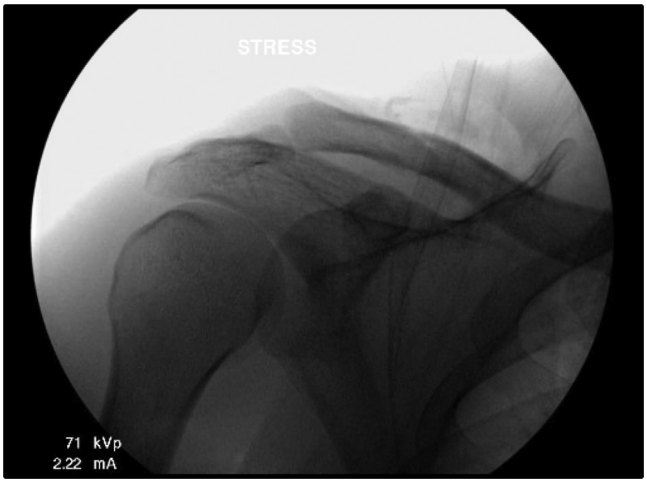

Figure 7 Intraoperative stress fluoroscopy. Stress fluoroscopy preformed after both FiberTape looped cerclages were tensioned. No visible change in clavicle positioning was observed and anatomic AC joint positioning was maintained. *AC*, acromioclavicular.

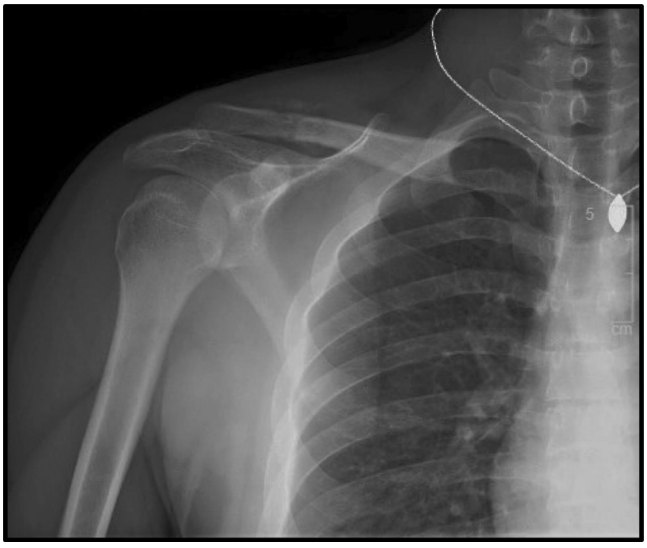

Figure 8 Six-week postoperative AP view radiograph after revision surgery displaying near anatomical alignment of AC joint. *AP*, anteroposterior; *AC*, acromioclavicular.

superior to the coracoid process (Fig. 9). The patient reported full range of motion and excellent strength with no functional limitations.

Discussion

This case report identifies a primary failure of a TTTR suspension device which has not been previously discussed in current literature. The revision technique chosen included 2 looped FiberTape cerclages placed laterally and medially corresponding to the trapezoid and conoid ligaments.

Recurrent postoperative AC joint instability has provided surgeons with complicated surgical challenges as there is no “gold standard” technique for revision surgical stabilization. However, there is widespread acceptance that nonanatomic reconstructions tend to demonstrate inferior joint stability when compared to anatomic reconstructions.[10] Additionally, the literature is sparse in regards to outlining the most effective salvage technique for

Figure 9 One-year postoperative AP view radiograph. Radiograph after revision surgery displaying reduced AC joint in near anatomical alignment with minimal heterotrophic ossification superior to AC joint. *AP*, anteroposterior; *AC*, acromioclavicular.

secondary AC joint reconstruction and whether salvage surgery is indicated.[8] AC joint salvage procedures require careful preoperative planning and identification of the cause of reinjury for proper surgical planning and appropriate patient education on postoperative protocols as patient noncompliance can be detrimental in terms of surgical success.[12]

Literature review of revision techniques

Our literature review was directed on primary and revision AC joint procedures including common causes of revision surgery (Table I). The most common causes of secondary AC joint complications that lead to revision surgeries were reported to be loss of reduction, hardware failure, vertical and horizontal displacement, infections, fractures, and calcifications.[5,7,11,13,16,17,21,23,25] Many studies indicated relatively high complication rates after initial AC joint fixation. However, a small percentage of these patients who had complications were noted to actually have a revision operation.[7,17,21-23] This is likely due to many unique factors such as the type of device and original hardware used in the primary operation and the type and degree of reinjury, whether the patient wanted another operation or if the surgeon recommended surgical revision. Furthermore, electing to proceed with nonoperative management after subsequent surgical failure and/or complication may be a reasonable option in patients desiring a low activity level, thus indications for AC joint reoperation may vary on population.[11] If a revision surgery was performed, we did not observe a common revision technique used among surgeons. The studies that listed the technique used during revision surgery included suspension devices, cerclages, or allografts.[7,17,18,21-23] This observation supports the point of the extensive surgical options and techniques available to surgeons in treating AC joint dislocations and the lack of a gold standard technique in primary or revision operations.

For the patient in this case, the TTTR device was chosen as the index fixation device at the surgeon’s discretion, over a double-looped cerclage technique, because the TTTR has been shown to

Table I
Literature review of acromioclavicular joint surgeries requiring revision operations.

Source	# Of patients	Primary procedure	Complication rate	Description of surgical failure	Salvage technique	Outcomes measured
Clavert et al[7]	116	Several Arthroscopic endobutton fixation techniques	9.4%	Hardware failure Coracoid fracture Infection	Endobutton replacement	Constant Score Radiographs DASH score
Zhang et al [24]	24	TightRope*	25% (8%, Salvage surgery needed)	Loss of reduction Hardware failure	Not specified	Constant Score UCLA Score Radiographs
Qi et al[17]	18	TightRope*	39% (17%, salvage surgery needed)	Ossification of CC interspace Infection Clavicle tunnel widening	Single Coracoid loop with FiberTape	ASES UCLA Score
Singh et al[18]	9	Tight Rope*	78% (33%, salvage surgery needed)	Loss of reduction Failure of suspension suture	Not specified	DASH Oxford Score
Cano-Martinez et al[3]	39	Twin Tail TightRope†	12%	discomfort with clavicular buttons horizontal instability	Not specified	Constant Score ACJI Radiographs
Wang et al[22]	60	Enodobutton‡ and Twin Tail TightRope†	28% (1.6%, salvage surgery needed)	horizontal instability	Cerclage added for stability	Constant Score Radiographs
Wei et al[23]	15	Triple endobutton‡	7% (7%, salvage surgery needed)	Coracoid button movement	Triple endobutton	Constant Score VAS
Tauber et al[21]	12	Modified Weaver-Dunn; Tension band wiring§ Bosworth screw fixation	All were revision surgeries (8.3%, clavicle fracture)	Hardware failure Persistent pain Joint weakness	Semitendinosus graft passed through coracoid drill holes in figure eight fashion	Constant Score Radiographs
Carofino et al[5]	17	Anatomic coracoclavicular ligament reconstruction fascial graft	18% (18%, salvage surgery needed)	Pain Loss of reduction Infection	Not specified	Constant Score ASES Radiographs
Milewski et al[16]	27	Anatomic reconstruction of coracoclavicular ligaments with fascial graft	51% (7%, salvage surgery needed)	Loss of reduction Coracoid fracture Clavicle fracture Hardware failure Infection	Not specified	Radiograph

DASH, Disabilities of the Arm, Shoulder and Hand score; *ASES*, American Shoulder and Elbow Surgeons Assessment; *UCLA*, University of California Los Angeles score; *ACJI*, Acromioclavicular Joint Instability Score; *VAS*, Visual Analog Scale; *CC*, coracoclavicular.
Device Reference.
*TightRope (Arthrex, Naples, FL, USA).
†Twin Tail TightRope (Arthrex, Naples, FL, USA).
‡Endobutton (Acufex, Smith & Nephew, Andover, MA, USA).
§FiberTape (Arthrex, Naples, FL, USA).

provide satisfactory horizontal and vertical stability with high tensile strength in cadaveric studies and has been efficacious in patients with debilitating, high-grade AC dislocations.[3,4,14,22] The TTTR system features 2 independent clavicle buttons and 1 coracoid button. Each button is joined by FiberWire (Arthrex, Naples, FL, USA) in a continuous loop; this "V" design enables surgeons to stabilize the AC joint in a manner that resembles normal CC ligament anatomy without increasing the risk of future complications. Additionally, the 2 independent clavicular buttons allow for pressure distribution across the clavicle further reducing chances of device failure and cut-through of bone. The surgical technique is simple; it does not need a graft nor has it shown to present with major complications, and material extraction is unnecessary. Furthermore, Cano-Martinez et al was one of the first groups to report on the TTTR functionality in a patient cohort. They used the TTTR device in 39 patients with type IV AC joint separations and reported a horizontal instability recurrence rate of only 12%, compared with 43%-52% when using other AC joint reconstruction methods.[3,4]

Nonetheless, a potential drawback of this device is the risk of coracoid fracture as the high load of failure of this device may be more than the load of failure of the patient's coracoid bone. However, to our knowledge, there are no reported failures of this device due to coracoid fracture.

During the revision surgery of this case, an Arthrex FiberTape cerclage double-loop suture technique was performed as it offers the advantage of restoring horizontal stability, creates an anatomic position for the AC and CC joints while avoiding graft donor morbidity, and will not require removal of hardware. The use of cerclage technique here is beneficial in that it required no associated risks of further coracoid drilling. Despite this being a challenging surgical technique, the advantages of using a cerclage technique with a tensioning system are that it allows the surgeon to precisely control the amount of reduction which aids in producing an anatomic repair of the CC ligaments. [24] Furthermore, when done correctly, this technique delivers anatomic stabilization with low risk of device migration and positive clinical outcomes.[19]

Without one catastrophic postoperative reinjury episode, it is difficult to pinpoint exactly why the TTTR device failed in this case as surgical device failure is often multifactorial. However, we hypothesize that the spacing of the 2 clavicular drill holes during the primary surgery was suboptimal. The clavicular drill holes and buttons were spaced approximately 10 mm apart when ideally the drill holes should be approximately 15 mm apart which would more closely restore conoid and trapezoid ligament anatomy. This spacing may have contributed to the device acting similarly to a single-suspension device rather than a double-suspension device, thus decreasing the repaired AC joint's multiplane stability. Additionality, the patient returned to activities too early after primary surgery which emphasizes the importance of clear physician-patient communication regarding postoperative expectations as well as a clear timeline to return to activities or sport.

Conclusion

The case presented here is one of the few reported examples of a failure of the triple-suspension TTTR device. Despite the large

number of AC joint fixation devices and techniques available, complications can still occur; thus, familiarization with revision techniques may be necessary for improving patient outcomes.

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