

Arthroscopically Assisted Acromioclavicular Joint Reconstruction Using the Infinity-Lock Button System With Allograft Augmentation



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Abstract: Acromioclavicular (AC) joint injuries are extremely common in the athletic population. Although most low-grade injuries can be managed nonoperatively, high-grade injuries often require reconstruction of the AC joint. Various reconstructive options have been described with varying risks and benefits to each. Implant or graft failure with loss of reduction as well as clavicle and coracoid fracture are a few of the more common complications following AC joint reconstruction surgery. Currently, no gold standard exists. This technical paper describes an arthroscopically assisted AC joint reconstruction technique using the Infinity-Lock Button System with hamstring allograft augmentation. This technique provides an anatomic, minimally invasive, low-profile reconstruction that may minimize risk of clavicle and coracoid fracture. It also provides augmented stabilization across the AC joint, which may also help resist naturally occurring horizontal and rotational displacing forces.

Acromioclavicular (AC) joint injuries are extremely common and represent 30% to 50% of all athletic shoulder injuries.¹ These injuries range from low-grade, types 1 and 2, which may be managed nonoperatively, to high-grade injuries, types 4, 5, and 6, which typically require surgical reduction and fixation. There is less consensus on the management of type 3 injuries. Most often, initial nonoperative treatment is recommended, although acute reconstruction may be recommended on a case-by-case basis.^{1,2} However, decision-making regarding nonoperative versus operative management

or the type of operative technique is complicated, given the absence of high-quality comparative studies.³

The anteroposterior stability of the AC joint is attributable to the AC joint capsule and the 4 AC ligaments, although the majority of horizontal stability is due to the posterior and superior AC ligaments.¹ The capsule is also a stabilizer against posterior rotation caused by scapular protraction.⁴ Vertical stability is provided by the coracoclavicular (CC) ligaments, the conoid medially, and the trapezoid laterally.

A vast number of implants and techniques have been described for reconstructing the AC joint. These include use of pins, plates, screws, allograft or autograft, all-suture based reconstructions, or transfer of the coracoacromial ligament (modified Weaver–Dunn) and use arthroscopic or open techniques.^{1,2} Complications following surgery are most commonly related to persistent discomfort, and hardware complications and are often technique dependent.^{2,3,5}

In this technical paper, we describe an arthroscopic-assisted AC joint reconstruction using the Infinity-Lock Button System (Xiros, Leeds, UK) with hamstring allograft reinforcement.

Surgical Technique (With Video Illustration)

The patient is placed in the lateral decubitus position (Video 1). General endotracheal anesthesia and a supraclavicular region block are used. An examination under anesthesia is performed, noting the degree of AC

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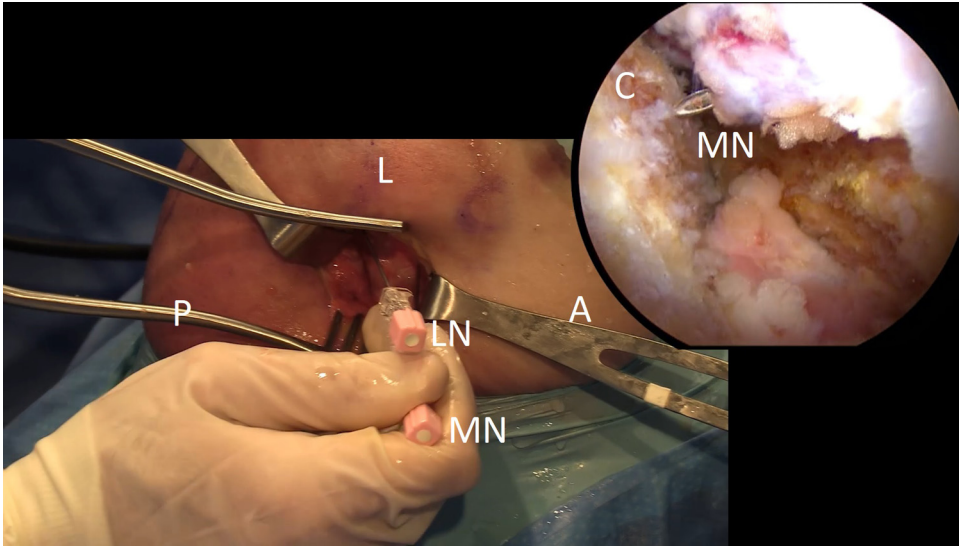


Fig 1. This is a left shoulder with the patient positioned in the lateral decubitus position. Anterior (A) is to the right, posterior (P) to left, lateral (L) is up. The lateral needle (LN) is in the acromioclavicular joint. The medial needle (MN) is through the fascia just anterior to the clavicle pointing towards the coracoclavicular ligament origin on the coracoid (C). This provides the trajectory for drilling the guide pin through the clavicle. The arthroscopic image is shown from the posterior portal through a 70° arthroscope confirming appropriate trajectory of the needle.

joint instability and reducibility. After routine skin preparation and draping, landmarks are marked out. With a ruler, the planned Infinity-Lock drill hole through the clavicle is marked approximately 3 to 4 cm medial to the AC joint.

A standard mid-posterior glenoid viewing portal is established followed by an anterior rotator interval portal. Visualization is accomplished with a 30° arthroscope. With a shaver, the rotator interval tissue is cleared away to identify the coracoid. We then switch to a 70° arthroscope for the remainder of the

case. Both the shaver and radiofrequency ablation are used to remove tissue circumferentially around the coracoid to provide visualization. One should be able to see the undersurface of the clavicle and the coracoid tubercle.

A saber incision is made half the distance between the AC joint and the planned clavicular drill hole. The deltotracheal fascia is taken down in a single layer longitudinally along the clavicle. Care is taken not to strip anteriorly or posteriorly to maintain the arthroscopic space underneath.

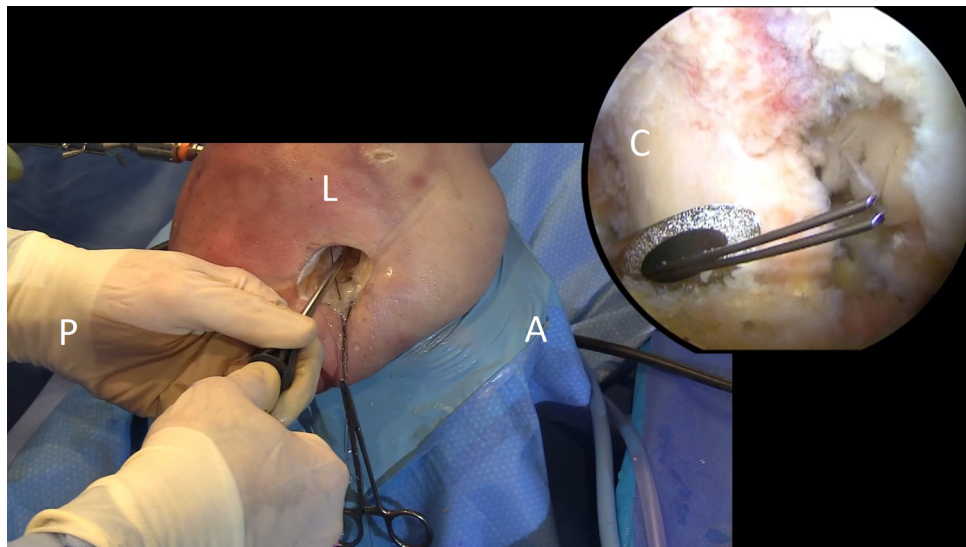
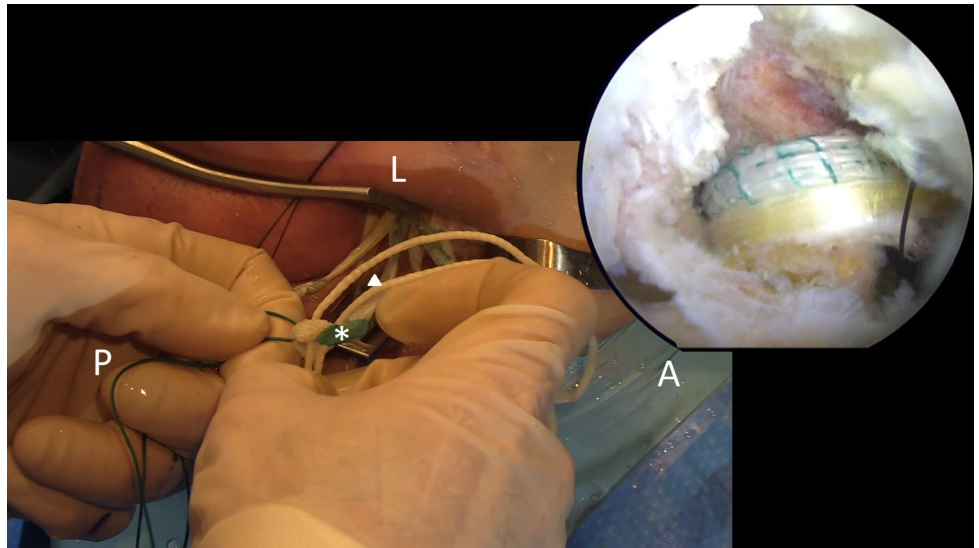


Fig 2. This is a left shoulder with the patient positioned in the lateral decubitus position. Anterior (A) is to the right, posterior (P) to left, lateral (L) is up. Coracoid passer is placed anterior to the clavicle through the fascial incision. It is slid down the medial aspect of the coracoid (C) underneath the coracoid. The arthroscopic image is shown from the posterior portal through a 70° arthroscope and demonstrates the coracoid passer underneath the coracoid aiming laterally. The tail ends of the nitinol wire have been passed through the passer and will be retrieved back through the fascial incision with a grasper.

Fig 3. This is a left shoulder with the patient positioned in the lateral decubitus position. Anterior (A) is to the right, posterior (P) to left, lateral (L) is up. The Infinity-Lock has been shuttled around the coracoid. Now, the tails (triangle) of the Infinity-Lock are loaded through the concave portion of the loop (asterisk) of the device. The arthroscopic image is shown from the posterior portal through a 70° arthroscope and demonstrates that the Infinity-Lock is around the base of the coracoid.



A needle is placed in the AC joint for reference. A second needle is placed 3 to 4 cm medial to the AC joint just anterior to the clavicle to verify the drilling trajectory over the anatomic insertion point of the CC

ligaments (Fig 1). A 2.4-mm drill pin is placed centrally through the clavicle 3 to 4 cm medial to the AC joint and directed toward to CC ligament origin of the coracoid. A 4.0-mm cannulated drill is passed over the

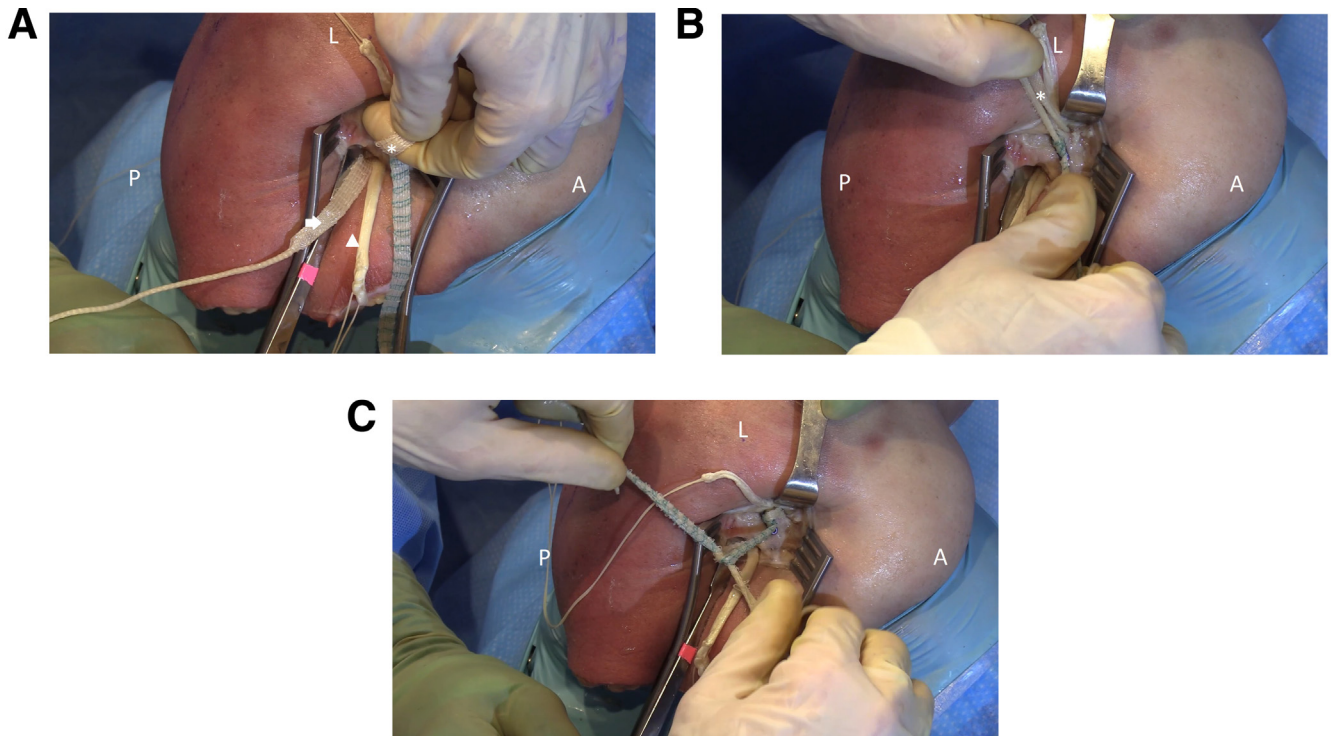


Fig 4. This is a left shoulder with the patient positioned in the lateral decubitus position. Anterior (A) is to the right, posterior (P) to left, lateral (L) is up. The 2 limbs of the Infinity-Lock have been passed up through clavicle and threaded through the Infinity-Lock Button. (A) One limb (arrow) is then partially shuttled underneath the clavicle from anterior to posterior leaving a loop anteriorly (asterisk). The limb of the hamstring graft (triangle) coming up the medial side of the coracoid is also passed simultaneously. (B) After the acromioclavicular joint is reduced and while maintaining the anterior loop (asterisk), the 2 limbs are tensioned to remove any slack from the system and a half-hitch is thrown. (C) The posterior limb is then completely passed posteriorly and knot-tying is finished minimizing any bulk superiorly that may cause irritation.

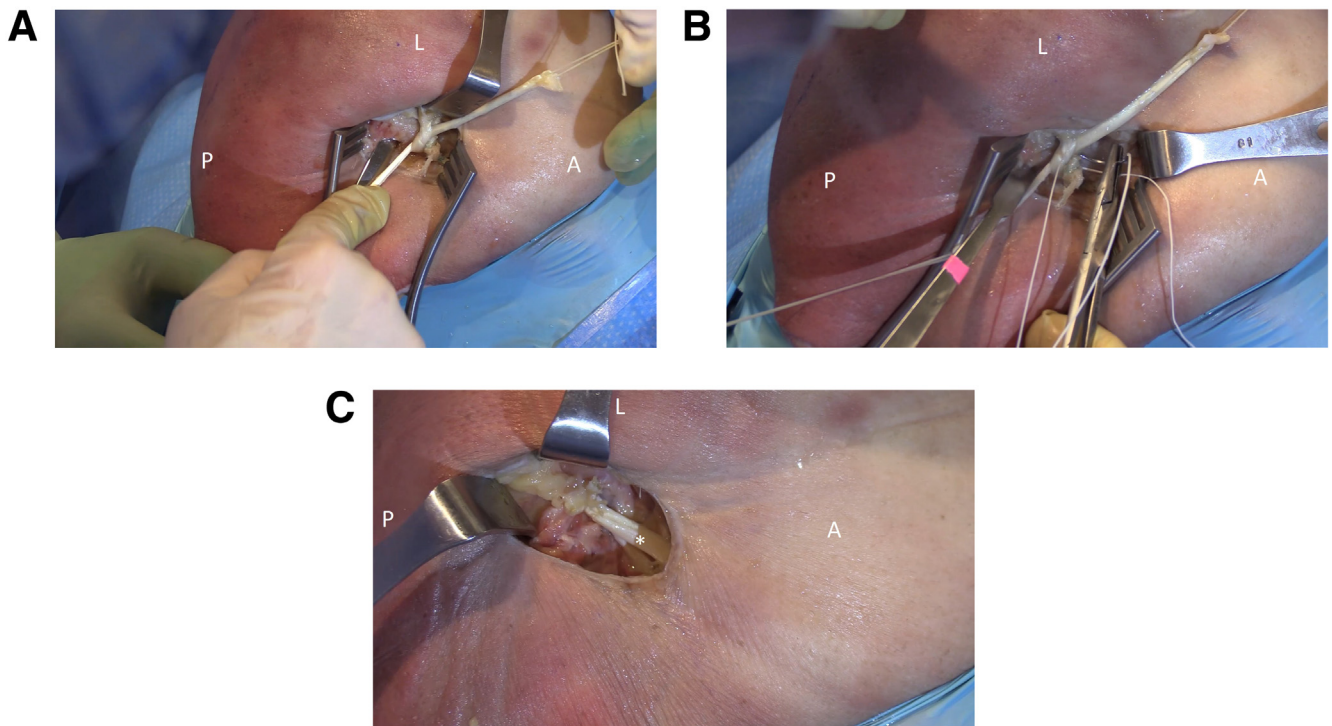


Fig 5. This is a left shoulder with the patient positioned in the lateral decubitus position. Anterior (A) is to the right, posterior (P) to left, lateral (L) is up. (A) The Infinity-Lock Button has been securely tied. A half-hitch is thrown in the hamstring allograft and the graft is tensioned so as to match the tension in the Infinity-Lock system. (B) Interrupted nonabsorbable #2 stitches are placed into the graft to secure it. (C) The tails of the hamstring allograft (asterisk) are taken laterally and sutured into the periosteum of the clavicle and across the AC joint to reinforce it.

pin drilling through the clavicle. The central drill pin is removed while keeping the drill in the clavicle. A nitinol wire is passed through the drill and shuttled out the rotator interval portal with a retriever. The drill is removed, leaving the nitinol wire in place. A 1-cm fascial incision is made anterior to the clavicle adjacent to the drill hole. The nitinol wire loop exiting out the anterior portal is retrieved through the fascial split.

The coracoid passer is placed through the fascial incision into the space between the clavicle and coracoid. The tip of the passer slides along the medial edge of the coracoid inferiorly coming around the base laterally (Fig 2). The tails of a second nitinol wire are placed through the passer and retrieved through the anterior clavicular fascial incision with a grasper. The coracoid passer is removed, leaving the nitinol wire around the base of the coracoid with the looped end on the medial side.

The hamstring graft may be prepared at any point. It should be whip-stitched at both ends using nonabsorbable suture. The green lead ETHIBOND suture (Ethicon, Somerville, NJ) of the Infinity-Lock is loaded into the loop of the nitinol wire around the coracoid. The Infinity-Lock is then partially shuttled from medial to lateral around the coracoid. Before it is pulled completely around the coracoid, a lead hamstring

suture is placed through the ETHIBOND lead suture just in front of the Infinity-Lock implant. Both are then completely shuttled. Both should move freely around the coracoid. The tails of the Infinity-Lock are loaded through the concave portion of the loop of the device and the green lead suture is removed (Fig 3). The tails are tensioned to synch the device around the coracoid. Toggling the tails helps remove any laxity. Direct palpation through the fascia as well as arthroscopic viewing allows confirmation the Infinity-Lock is secured around the coracoid.

Table 1. Postoperative Protocol After Arthroscopic-Assisted Acromioclavicular Joint Reconstruction Using Infinity-Lock Button System With Hamstring Allograft Augmentation

Postoperative Period	Rehabilitation Process
Immediate	Patient is immobilized in a sling with an abduction and derotation pillow.
0-6 weeks	Use of the sling and pillow continues; elbow, wrist, and hand range-of-motion exercises are permitted.
6-8 weeks	Use of the sling is discontinued; active-assisted range of motion is begun.
8-16 weeks	Isometric rotator cuff strengthening is started and progressed as tolerated.
16-24 weeks	Sports-specific training is performed.
>24 weeks	Return to full activity.

Table 2. Advantages and Risks of Surgery

Advantages	Risks
Minimally invasive, arthroscopic assisted	Risks of allograft use
Low profile	Risk of neurovascular injury
Stabilization across acromioclavicular joint	Risk of clavicle fracture
Additional stability with biologic augmentation	Cost of implant and allograft
Minimizes risk of fracture <ul style="list-style-type: none"> • Single drill hole through clavicle • Decreased stress risers 	

The tails of the device are loaded through the remaining nitinol wire loop. The tails are then shuttled through the clavicle from inferior to superior. The tails are loaded through the center 2 holes of the Infinity-Lock button, which is approximated to the clavicle. Next, the coracoid passer with nitinol wire is placed from posterior to anterior underneath the clavicle. This allows shuttling of a single tail of the Infinity-Lock device along with the hamstring lead suture traversing up from the medial side of the coracoid. Incompletely shuttle the Infinity-Lock limb to leave a loop anteriorly (Fig 4). The 2 tails are tensioned to reduce the AC joint. A half hitch is tied. While maintaining tension, the posteriorly passed limb is completely shuttled and the knot stack is completed on the posterior surface of the clavicle. The hamstring tails are tied in a half hitch and tensioned to match the Infinity-Lock construct (Fig 5). Interrupted #2 nonabsorbable sutures are placed into the hamstring half-hitch to secure the graft. The tails of the graft are brought over the top laterally and sewn into the periosteum to reinforce the AC joint. The deltotracheal fascia is closed followed by a standard skin closure.

Rehabilitation

Following the procedure, the patient is immediately placed in a sling with an abduction and derotational pillow (Table 1). For the first 6 weeks, the patient remains in the sling at all times except to perform elbow, wrist, and hand range-of-motion exercises. After 6 weeks, the sling is discontinued and active-assist shoulder range of motion is started with a physical therapist. Starting at 8 weeks postoperatively, isometric rotator cuff strengthening is started and progressed as tolerated. Sports-specific training commences at 16 weeks postoperatively, and patients are permitted to return to full activity at 24 weeks.

Discussion

Options for AC joint reconstruction are varied, and no current gold-standard exists. A recent meta-analysis

and systematic review found the overall failure rate for AC joint reconstruction to be around 20%.⁵ There were no significant differences in failure rates between the majority of the surgical techniques. Anatomic reconstructions have, however, been shown to have improved failure rates over the nonanatomic Weaver–Dunn procedure.^{6,7} Arthroscopic procedures also do not seem to have better failure rates compared with open.⁵

Complications are fairly common after AC joint reconstruction, with infection occurring most frequently (6.3%), followed by clavicle or coracoid fracture (5.7%) and hardware/button failure (4.2%).⁵ A database study showed similar results with a reoperation rate of 1.6% for irrigation and debridement, 4.2% for revision reconstruction, and 6.2% for hardware removal all within the first 6 months of surgery.⁸

Many complications are technique-specific. Techniques requiring drilling the clavicle or the coracoid may have as high as an 18% risk of clavicle fracture or up to a 20% risk of coracoid fracture.⁹ Graft elongation and loss of fixation with implant cut-out, particularly with suture button reconstructions, also contribute to a high rate of failure.⁶ Spencer et al.⁷ found that combining allograft loop fixation with suture button fixation yielded a significantly lower failure rate than allograft fixation alone.

Repair of the AC joint capsule is also not without debate. Yet, some biomechanical studies indicate that repair of the capsule with CC ligament reconstruction most closely restores resistance to normally experienced translational and rotational forces.¹⁰

The Infinity-Lock Button System has not been evaluated against other reconstruction techniques. However, this technique theoretically helps minimize fracture risk, as there is no drill hole in the coracoid and only a single drill hole in the clavicle (Table 2). Augmentation with hamstring allograft helps increase the stability of the repair and may help further mitigate fracture risk by decreasing the stress riser from the implant. The resulting fixation is low profile and decreases the chance of irritation from bulkier fixation methods. In addition, laying the tails across the AC joint and suturing them to the periosteum may provide additional stability across the AC joint. This technique is fairly minimally invasive and use of the arthroscope assists in anatomic graft and implant placement around the base of the coracoid.

Overall, this technique provides an arthroscopically assisted anatomic reconstruction of the CC ligament through a minimally invasive incision with minimal implant bulk, decreasing the risk of irritation of the construct. Risk of fracture is minimized and additional stability is provided via augmentation of the AC joint.

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