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The Acromioclaviculare Distal Clavicle 3-Dimensional All-Suture Stabilization Technique Without Need for Fluoroscopy and Without Metallic Hardware

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The AcromioclavicularеDistal Clavicle 3-Dimensional All-Suture Stabilization Technique Without Need for Fluoroscopy and Without Metallic Hardware

Marouane Bouloudhnine

Abstract: The acromioclavicular joint's intricate biomechanics and anatomy pose significant challenges in its repair. Recent advancements have emphasised the need to address both vertical and horizontal instability. A recent surgical approach, the "Closing the Circle" (CTC) technique, was introduced to provide comprehensive stabilisation by addressing vertical, horizontal, and rotational forces, aiming to restore the coracoacromioclavicular stability circle as a 3D reconstruction. The "AC-DC 3D All Suture stabilisation technique". Uses of uni cortical self-punching all-suture anchors, which reduce nerve damage risks and remove the use of metallic components such as cortical buttons, thus making it a cost-effective option. This technique emphasises three core objectives by making the surgical process safe and efficient.

The three-dimensional acromioclavicular joint's (ACJ) behaviour and its close anatomical relationship with the coracoid process have been subjects of significant discussion over the past decade. As our biomechanics' comprehension behind the injuries of ACJ has advanced, it has become evident that restoring both the acromioclavicular and coracoclavicular ligaments is crucial, as ACJ involves more than just the joint between the distal clavicle and the acromion1-5. Recent research highlights the significance of handling vertical and horizontal instability to achieve optimal outcomes in the surgical treatment of acute grade IIIB-V ACJ dislocations. However, a universally accepted gold standard technique has yet to be established [4,5,6].

Recognising that the ACJ is part of the coraco-acromio-clavicular ligamentous complex, maintaining its integrity is essential for the joint's proper biomechanical function. A recent surgical approach, the "Closing the Circle" (CTC) technique1, was introduced to provide comprehensive stabilisation by addressing vertical, horizontal, and rotational forces, aiming to restore the coracoacromioclavicular circle of stability.

One of the significant clinical challenges linked with the CTC technique is to properly deliver the all-suture anchors beneath the inferior cortex of the coracoid [1].

The current technical note presents the 'AC-DC 3D All Suture Stabilization Technique' (a modification of the current CTC technique) to address the above-discussed challenges by simplifying the procedure. Simplify the procedure using unicortical, self-punching all-suture anchors, avoiding metallic hardware use, and eliminating the need for fluoroscopy by directly visualising anchor placement at the top of the coracoid.

This technique reduces the risk of nerve or hardware issues and is safe, efficient, and cost-effective.

The Case

A 32-year-old right-handed male, an IT engineer, fell on a snowboard front angle 6 days prior to surgery. Severe pain in the right shoulder. The right clavicle is markedly elevated. The X-ray test revealed that the distance of the coracoclavicles on the right side was 23.5 mm and it was 11.3 mm on the normal side (the left side), which is nearly

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twice normal (Fig 1). Therefore, it is stage IIIB or stage V of Rockwood.

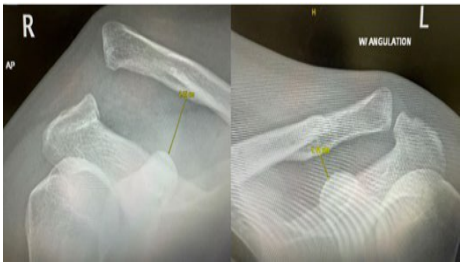


Fig 1. On the left shoulder, there is an increased distance between the two coracoids: on the right, the distance is 2.35 cm, while on the left is 1.15 cm, indicating that the separation is almost twice as much. The image is a confirmatory diagnosis of a 32-year-old male consequent to a snowboarding injury. The patient is upright, as shown in Figure 1 Patient positioned in the beach chair position; right shoulder shown Abbreviations: R = Right; L = Left; AP = Anteroposterior.

Surgical technique

Video 1 has demonstrated an example of the surgical technique, and it is further shown in Figures 3-11 – Figure 10 represents the final paradigm. Figures 1 and 12 show the pre and post-operation X-ray. Informed consent in detail was obtained for the procedure described. Video 1 has demonstrated an example of the surgical technique, and it is further shown in Figures 3-11 – Figure 10 represents the final paradigm. Figures 1 and 12 show the pre and post-operation X-ray. Informed consent in detail was obtained for the procedure described.

Patient Preparation

The patient is placed in a beach chair position on a surgical table with a removable shoulder support (Fig). No fluoroscopy is used. The ipsilateral upper hemithorax and upper limb are draped sterilely after being prepared. Anatomical marks are drawn using a demographic pen.

Surgical Approach

A skin incision that is 10 cm longitudinal is made, initiating medially and then extending it laterally over the third lateral of the clavicle, crossing the acromioclavicular joint (ACJ) and ending at the acromion's anterior border (Fig 3). The lateral clavicle part of the deltoid is found detached; however, the trapezius is still attached (Fig 4). The coracoid process and remnants of the coracoclavicular ligaments are identified and palpated anteriorly to the distal third of the clavicle, with minimal dissection in this area to preserve the remaining torn ligaments (Fig).



Fig 2. The patient is being placed in the beach chair setup with the upper limb at the side in neutral flexion for operative exposure of the clavicle, coracoid, and AC and in an anterior direction, as shown in Figure 2. It is intended for surgical exposure of the clavicle, coracoid, and acromioclavicular joint. Patient positioned in the beach chair position; right shoulder shown.

Surgical Approach

Under direct visualisation of the entire coracoid after splitting the deltoid, two all-suture self-punching anchors are inserted into the base of the coracoid, unicortically. (*Self-punching 2.6 FiberTak® Suture Anchors, double-loaded with 1.3 mm Suture Tape from Arthrex®*), eliminating the need for fluoroscopy (Fig6). We are and test all-suture anchor strength by pulling it until we feel it locked.

The two anchors are placed posteriorly at the base of the coracoid, on its knee, one medial and one lateral. The first anchor is positioned posteromedially to reconstruct the conoid ligament, while the second anchor is placed anterolaterally, still at the top of the coracoid, to separately reconstruct the trapezoid ligament (Table A)

Coracoclavicular Preparation

This step is performed before the acromioclavicular joint (ACJ) reduction as the clavicle's posterior displacement aids the approach of the process of coracoid as well as the anchors' placement. No dissection is needed on the medial or inferior side of the coracoid, which helps save time and reduces the risk of damaging the brachial plexus beneath the coracoid (Table 1). We use the same small 2.5 mm drill bit for all bone tunnels. Two vertical tunnels are then drilled into the clavicle. The lateral one is at 2,5 cm from ACJ and the medial one is at 4 cm. We need to keep a minimum distance of 15 mm between both to avoid clavicle fracture (Fig 7).

Acromioclavicular (AC) Preparation

The acromioclavicular joint (ACJ) is cleared of fibrous remnants and hematoma. The next step is drilling two tunnels with the same drill of 2.5mm in the anterior-to-posterior direction: one crossing the clavicle's lateral edge and the other crossing the acromion's anterior portion (Fig 7).

Coracoacromioclavicular Complex Repair

It is done in two separate steps (Fig 8):

1. Coracoclavicular Repair is based on the same medial anchor (2 tapes, four limbs):

Using a Suture loop, we pass two tapes (2 and 3 in Figure 6) of the medial coracoids, anchoring through the clavicle's lateral vertical tunnel and medial vertical tunnel from down to up. Later, each limb of the tape passes into the other vertical tunnel to tie the knot by crossing the limbs, allowing to tie the knot at the anterior inferior part of the clavicle without any need for a cortical button.

2. Acromioclavicular Repair is based on the same lateral anchor (2 tapes, four limbs):

Using the same suture loop, one limb (number 1 in Fig 6) of the tape of the lateral coracoid anchor is passed over the clavicle and introduced into the clavicular horizontal tunnel from posterior to anterior. The second tape's remaining two limbs (1' Fig 6) pass in opposite directions, one anterior to posterior in the clavicle and the second to anterior in the acromion. At the end, the acromioclavicular capsule repair should be on Eight-figure.

Joint Reduction and Stabilisation

The arm is placed as a "shoulder shrug" to help reduce ACJ with minimal tension. After checking the reducibility of the dislocation (Fig), a temporary k-wire is used to maintain the reduction. Then, the limbs of the suture from the horizontal tunnels are passed, and, in Figure, -eight- a suture pattern is used around ACJ, with the remnants of the capsular involved when possible.

Final reconstruction is then checked (Fig 10), and by moving the arm through the complete motion range of the shoulder girdle, the dynamic joint is assessed under direct visualisation.

Postoperative Management

The deltotrapezial fascia is closed strongly using Mason Allen sutures (Fig 11). The surrounding tissue is involved in the capsule of ACJ, and if possible, the platysma is repaired and the skin is closed with the help of the technique of intradermal suture. The wound is then carefully covered with sterile strips to avoid tension on the skin and to minimise hypertrophic scar tissue formation. The X-ray post-op can show the stability of the repair (Fig 12) and the anatomical restoration of the coracoclavicular distance. Emerging remote health monitoring systems may further support postoperative surveillance by enabling continuous assessment of patient recovery and early identification of complications through scalable telemedicine platforms.[12]

Discussion

Several techniques have been proposed to restabilise the ACJ following grade IIIB-V acute dislocations, with a historically high grade of reduction subsidence and construct failure.[7,8] More recently, the importance of AC ligaments and capsule repair has been highlighted due to their central role in ACJ horizontal and rotational stability, and many different stabilisation methods have been proposed.[4,9]

However, this technology has potential drawbacks, including the reliance on fluoroscopy imaging techniques for optimal anchor placement. The newly modified technique named ‘AC-DC 3D All Suture Stabilisation Technique' provides various benefits for managing acute ACJ dislocations by revising the CTC technique with the addition of self-punching all-suture anchors [10].

Remote monitoring technologies are increasingly being incorporated into postoperative patient care. Scalable telehealth architectures allow clinicians to remotely track patient recovery, functional outcomes, and potential complications following surgical interventions. Such systems can reduce hospital visits while improving continuous monitoring and early detection of postoperative issues. Previous studies have demonstrated that integrated remote health monitoring platforms can provide cost-effective and scalable solutions for patient follow-up in modern healthcare systems.[12]

There are still several limitations that must be acknowledged before implementing this technique:

1. The surgeons who have undergone spring-school in Video-Assisted Minimally invasive (VAM II) principals are bound to undergo a severe learning curve in observing this new act as they are not conversant with the idea of self-punching all-suture anchor placement. [11].
2. While promising, the modified technique may only be suitable for specific participants and not applicable to all. For example, specific acute joint dislocations or fractures may necessitate different stabilisation approaches.
3. Besides the favourable initial outcomes offered by this technique, there is still a need for in-depth research and continuing investigation to determine its long-term outcomes and stability for a wider population of patients.

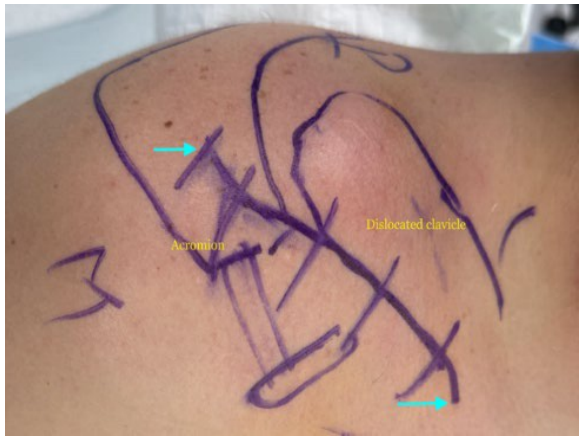


Fig 3. Green arrow: incision marked with a dermographic pen in a superolateral view, as shown in Figure 3. A 10 cm long incision is made over the lateral third of the clavicle, extending laterally across the acromioclavicular joint and terminating over the acromion. Patient positioned in the beach chair position; right shoulder shown.



Fig 4. There is partial detachment of the deltoid muscle and complete dislocation of the AC joint on a superior view of the right shoulder with a partial detachment of the trapezius at its clavicular insertion, as shown in Figure 4 Patient positioned in the beach chair position; right shoulder shown.

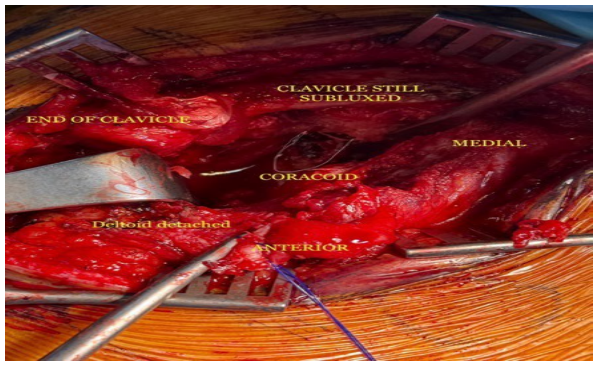


Fig 5. The separated lateral clavicle that has been dislocated occurs naturally in association with an anterior deltoid detachment. Immediate visualisation of the coracoid base, lateral, and medial walls is possible without requiring pectoralis minor dissection. Pectoralis minor can be elevated gently with a periosteal elevator, as shown in Figure 5 Patient positioned in the beach chair position; right shoulder shown.

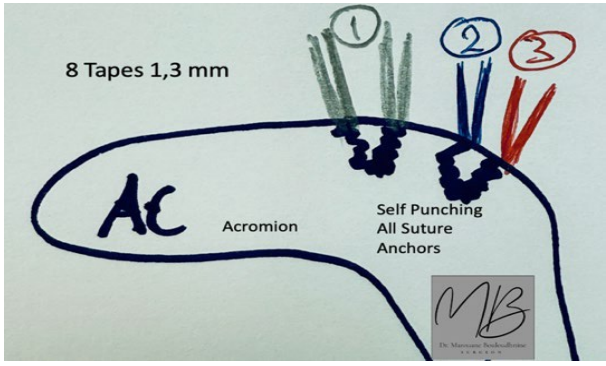


Fig 6. Figure 6 shows that insertion is carried out under the jaws' direct visualisation on a medial-to-lateral placement on the coracoid without penetration of the inferior cortex. A 2-mm predrill is utilised in hard bone to prevent slippage. Each anchor carries two 1.3-mm suture tapes (4 limbs in total) Patient positioned in the beach chair position; right shoulder shown.

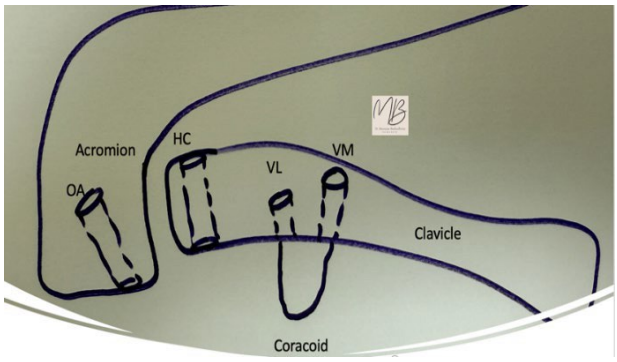


Fig 7 Figure 7 shows that in all, four tunnels were prepared: Two medial vertical (VM) and lateral vertical (VL) tunnels in the clavicle, one horizontal tunnel at the end of the clavicle (HC), and one oblique tunnel in the acromion (OA), which provides for a passage for suture limbs for CC and AC ligament reconstruction. Patient positioned in the beach chair position; right shoulder shown.

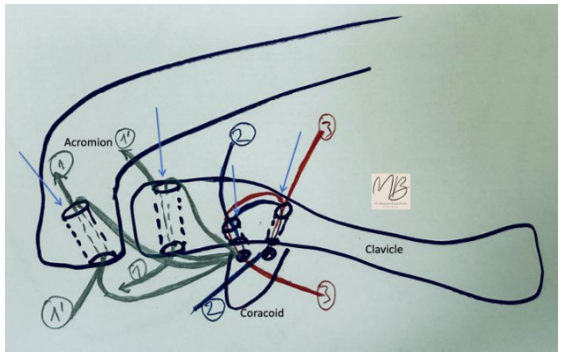


Fig 8 Figure 8 shows stepwise the suture tape passes for CC and AC ligament reconstruction. Medially, two suture tapes traverse from inferior to superior through the vertical tunnels in the clavicle, which are crossed to reconstruct the CC ligaments. A limb from the lateral anchor goes over the clavicle into the horizontal tunnel (from posterior to anterior) and through the acromion (from anterior to posterior). The remaining taped limbs make a pass in the mirror. Patient positioned in the beach chair position; right shoulder shown.

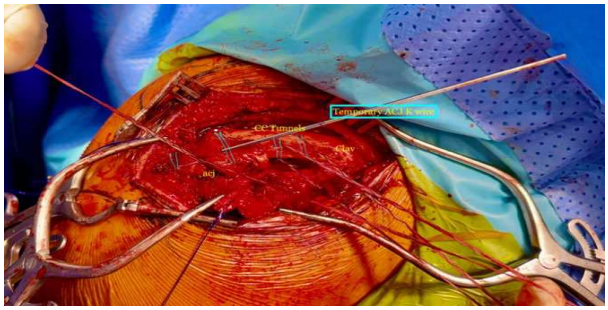


Fig 9 Figure 9 shows the right shoulder's lateral view, showing the correctly oriented clavicular and acromioclavicular articulation tunnels (green lines) created anatomically to recreate the corresponding coracoid coracoid and acromioclavicular ligaments. The tunnels are positioned approximately 2.5 and 4 cm medial to the acromioclavicular junction line. Patient positioned in the beach chair position; right shoulder shown.

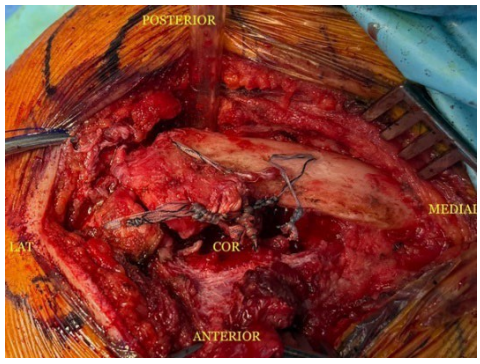


Fig 10 Figure 10 shows an intra-operative superior view of a completed reconstruction with an anatomical alignment of the ACJ and secure suture ribbons to keep them reducible. Patient positioned in the beach chair position; right shoulder shown.

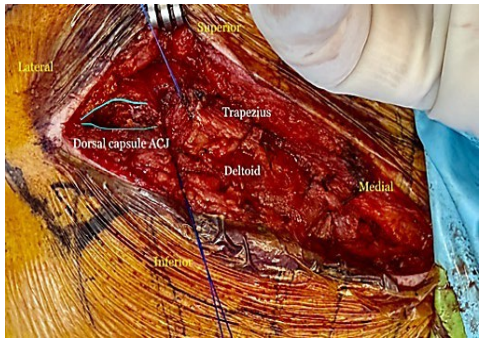


Fig 11 Sicilian view left shoulder intraoperative with the deltotrapezial fascia appearing to be rejoined and acromioclavicular (ACJ) capsule plicated in order to place the right shoulder and its new position at horizontal stability. Anatomical reference gives names trapezius and deltoid muscles placed with the lateral medial superior and inferior orientations. The patient is lying on a beach chair position; right shoulder is demonstrated. Abbreviations One can use R (Right), L (Left), AP (Anteroposterior).

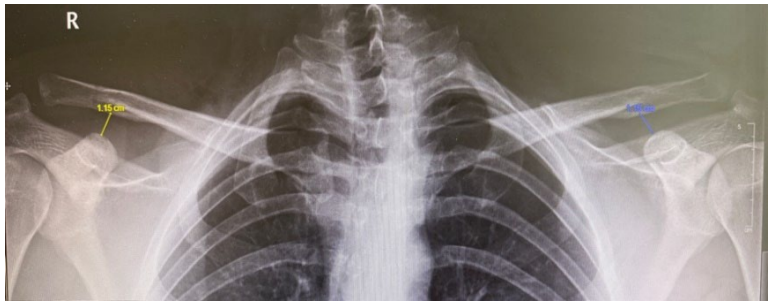


Fig 12 Figure 12 shows radiograph shows maintained ACJ alignment with reduced coracoclavicular distance, thus confirming that the repair is structurally intact. Duration of follow-up: [Insert duration, e.g., 6 weeks]. Patient positioning: upright AP view. Patient upright in beach chair position; right shoulder shown, Abbreviations: R = Right; L = Left; AP = Anteroposterior.

Table 1. Pearls and Pitfalls of the "AC-DC 3D All Suture" Technique

PEARLS	PITFALLS
• Identify and reference the deltotrapezial fascia, if possible. • Carefully dissect the soft tissues around the lateral clavicle to facilitate ACJ reduction and placement of tunnels. • Spare the trapezius insertion near the posterior capsule of the ACJ • Use your finger to palpate the coracoid position • Make a partial vertical split in the deltoid to access the acromion (if needed; usually Anterior Deltoid is already detached in the IIIB/V stage) • Dissect the lateral, medial and the base of the coracoid • No need to dissect the pectoralis minor; A small retractor is placed at its top to see the knee of the coracoid process • If you find a damaged ACJ meniscus, remove it • Both coracoclavicular and acromioclavicular tunnels should be done before ACJ reduction (4 tunnels). • Use the same small drill bit to perform all four tunnels (2,5mm) • Use a Suture Loop to shuttle the suture limbs through the tunnels. • Use a Self-punching all suture anchors. • Use a 2 mm drill to prepare the entry point of the Anchors (2,6mm) at the base of the coracoid (hard bone) • Use different clamps to reference and differentiate the sutures from the two coracoid anchors. • Use temporary Kwire to reduce the AC joint before tightening the knots • First, Tie the coracoclavicular knots in front of the clavicle (no knots at the top) • Second, proceed to tighten the ACJ in 8-figure if possible, incorporating all possible AC capsuloligamentous remnants	• Make sure to visualise the entire coracoid (base, lateral and medial parts) • Make sure to pre-drill the coracoid entry points of the anchors • Always arm and test all-suture anchor strength by pulling it until you feel it locked • Avoid extensive debridement in the coracoclavicular space to avoid damaging the coracoclavicular ligament remnants. • During ACJ dissection and tunnel placement, avoid damaging the upper trapezius insertion on the posterosuperior aspect of the ACJ capsule and lateral clavicle (preserve ACJ stability). •

Table 2. Advantages of the "AC-DC 3D All Suture ACJ" Stabilisation technique

ADVANTAGES
• The AC-DC 3D ALL Suture ACJ Stabilization is a true "all-suture technique" with no use of metallic hardware such as endo button or cortical button (cost-saving, time-saving, potential complication avoided) • Self-punching anchors avoid the pre-drill needed for regular anchors and the difficulty of finding the correct hole (quicker procedure) • Direct visualisation of the entire coracoid process avoids the blind placement of the anchors • Unicortical drill of coracoid for anchor placement (under direct visualisation) avoids increasing risk of fracture (safer) • 15 mm are left between the two clavicle tunnels • All-suture anchors placement under direct visualisation into the base of the coracoid does not need for a medial dissection of the pectoralis minor (safer) • No need for a time-and resource-consuming Fluoroscopic setting (time-saving)
DISADVANTAGE
• The technique may require a learning curve for surgeons unfamiliar with all-suture systems. • Visualisation and access to the coracoid base may be limited in patients with complex anatomy. • Limited long-term clinical outcome data compared to established hardware-based techniques.

References

1. Ângelo, Ana Catarina, et al. "Combined Vertical, Horizontal, and Rotational Acromioclavicular Joint Stabilization: 'Closing the Circle' Technique." Arthroscopy Techniques, vol. 11, no. 8, Elsevier BV, July 2022, pp. e1479–86, https://doi.org/10.1016/j.eats.2022.03.039. Accessed 24 Jan. 2025.
2. Saier T, Venjakob AJ, Minzlaff P, et al. Value of additional acromioclavicular cerclage for horizontal stability in complete acromioclavicular separation: A biomechanical study. Knee Surg Sports Traumatol Arthrosc 2015;23: 1498-1505.
3. Peeters I, Braeckevelt T, Herregodts S, Palmans T, De Wilde L, Van Tongel A. Kinematic alterations in the shoulder complex in rockwood V acromioclavicular in- juries during mesothoracic and scapulothoracic movements: A whole-cadaver study. Am J Sports Med 2021;49: 3988–4000.
4. Dyrna F, Imhoff FB, Haller B, et al. The primary stability of an acromioclavicular joint repair is affected by the type of additional reconstruction of the acromioclavicular capsule. Am J Sports Med 2018;46:3471-3479.
5. Celik H, Chauhan A, Flores-Hernandez C, et al. Vertical and rotational stiffness of coracoclavicular ligament reconstruction: A biomechanical study of 3 different techniques. Arthroscopy 2020;36:1264-1270.
6. LeVasseur MR, Mancini MR, Kakazu R, et al. Three-dimensional footprint mapping of the deltoid and trapezius: Anatomic pearls for acromioclavicular joint reconstruction. Arthroscopy 2022;38:701-708.
7. Martetschläger F, Horan MP, Warth RJ, Millett PJ. Complications after anatomic fixation and reconstruction of the coracoclavicular ligaments. Am J Sports Med 2013;41: 2896-2903.
8. Woodmass JM, Esposito JG, Ono Y, et al. Complications following arthroscopic fixation of acromioclavicular separations: A systematic literature review. Open Access J Sports Med 2015;6:97-107.

9. Morikawa D, Dyrna F, Cote MP, et al. Repair of the entire superior acromioclavicular ligament complex best restores posterior translation and rotational stability. Knee Surg Sports Traumatol Arthrosc 2019; 27:3764-3770.
10. White, Charles C., and Brandon A. Cincere. "Acromioclavicular Joint Reconstruction with Acromioclavicular Ligament Augmentation Using a Knotless, All-Suture Anchor Construct." Arthroscopy Techniques, Sept. 2024, p. 103226, https://doi.org/10.1016/j.eats.2024.103226.
11. Fung G, Sha M, Kunduz B, Froghi F, Rehman S, Froghi S. Learning curves in minimally invasive pancreatic surgery: a systematic review. Langenbeck S Archives of Surgery. 2022;407(6):2217-2232. doi:10.1007/s00423-022-02470-3.
12. Hemairy MA, Amin S, Hijji M, Serhani M, Ahmad MA. Integrated and Scalable Architecture for Providing Cost-Effective Remote Health Monitoring. Proceedings of the International Conference on Developments in eSystems Engineering. 2016:74-80. doi:10.1109/dese.2016.14.