Technical Note

Ulnar Collateral Ligament Repair With Internal Brace Using Linked Knotless Suture Anchors

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Abstract: This article presents an adaptation of the internal brace ulnar collateral ligament (UCL) repair technique using knotless suture anchors, which shows promise for improved postsurgical functionality and a shortened recovery period in patients with UCL injuries. Traditional methods of UCL reconstruction often require a lengthy 12- to 18-month recovery period, presenting a significant challenge for athletes keen to return to their sport. The modified technique uses smaller sutures and drill holes, thereby eliminating the need for larger anchors and simplifying the surgical process. Furthermore, we provide a comprehensive exploration of the rehabilitation protocol involved after surgery, which includes various phases of physical therapy and use of the "thrower's ten" program to improve shoulder and elbow stability, strength, and mobility. This technique paves the way for a promising alternative to traditional UCL reconstruction or repair methods, with the potential to significantly enhance clinical outcomes, improve recovery times, and positively impact athletes' lives.

The ulnar collateral ligament (UCL) is a crucial structure that stabilizes the medial aspect of the elbow joint during throwing activities. Studies by Werner et al.[1] (1993) and Fleisig and Escamilla[2] (1996) recorded the forces generated while pitching. During the baseball pitch, the UCL appears to be loaded near its maximum capacity, regularly bearing 30- to 40-Nm forces while pitching, with Dillman[3] (1991) reporting a 32-Nm failure force for the UCL.[1,2,4]

Traditional UCL reconstruction with a graft has successfully allowed individuals to continue playing baseball, but recent techniques have sought to improve postsurgical functionality and decrease rehabilitation time.[5,6] In a 2008 study by Savoie et al.,[7] UCL repair using suture anchors showed promise as an alternative to traditional reconstruction, allowing for a quicker recovery. Dugas et al.[8] (2019) built on this by introducing joint-spanning suture augmentation, or internal brace augmentation, which similarly expedited the return to play without compromising functional outcomes. Both techniques offer shorter rehabilitation periods than traditional 12- to 18-month protocols.[8] Another purported advantage of the internal brace technique is the use of collagen-coated tape sutures; however, regular sutures could prove just as effective.[9] The studies concluded that both UCL reconstruction and UCL repair with an internal brace effectively restored elbow joint torque and stiffness to levels similar to those seen in an intact joint, and neither resulted in overconstraint of the elbow joint.

After the aforementioned studies, Bernholt et al.[10] (2019) found that UCL reconstruction with internal brace augmentation offers improved stiffness and strength at time zero compared with the conventional docking method. However, the combination requires drilling holes into the elbow for both reconstruction and the internal brace, which can make the procedure more challenging. Additionally, if the internal brace fails and reconstruction is later needed, the 3.0-mm hole created in the ulna may impact future drill hole placement.

An adjustment to the traditional internal brace technique involves using small suture anchors (two 1.8-mm FiberTak anchors; Arthrex). With smaller sutures, the knotless anchor UCL repair technique achieves an internal brace effect that can be more easily combined with reconstruction. Furthermore, using No. 2-0 FiberWire (Arthrex) requires much smaller drill

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Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Quicker recovery time compared with traditional reconstruction	Limited long-term studies to validate longevity
Smaller drill holes, reducing surgical trauma; morbidity reduced if reconstruction needed later	Smaller tape suture; less force distribution
Easier to execute with knotless suture anchors; no hard body anchors (two 1.8-mm FiberTak anchors)	Best suited for acute tears, not chronic conditions
No. 2-0 FiberWire with lower profile and less risk of articular cartilage irritation	Associated risks and need for activity modification
Less invasive muscle-splitting technique	Requires understanding of anatomy and avoidance of suture malpositioning

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Faster return to normal activity	Long-term efficacy not as well studied as traditional reconstruction
Smaller, less invasive drill holes	Limited to acute tear conditions
Knotless suture anchors simplify procedure	Lack of rigid non-absorbable suture anchors
No. 2-0 FiberWire reduces chances of irritating joint cartilage	Decreased strength compared with larger suture
Comparable joint torque and stiffness to traditional methods	Costs associated with specialized equipment such as knotless suture anchors

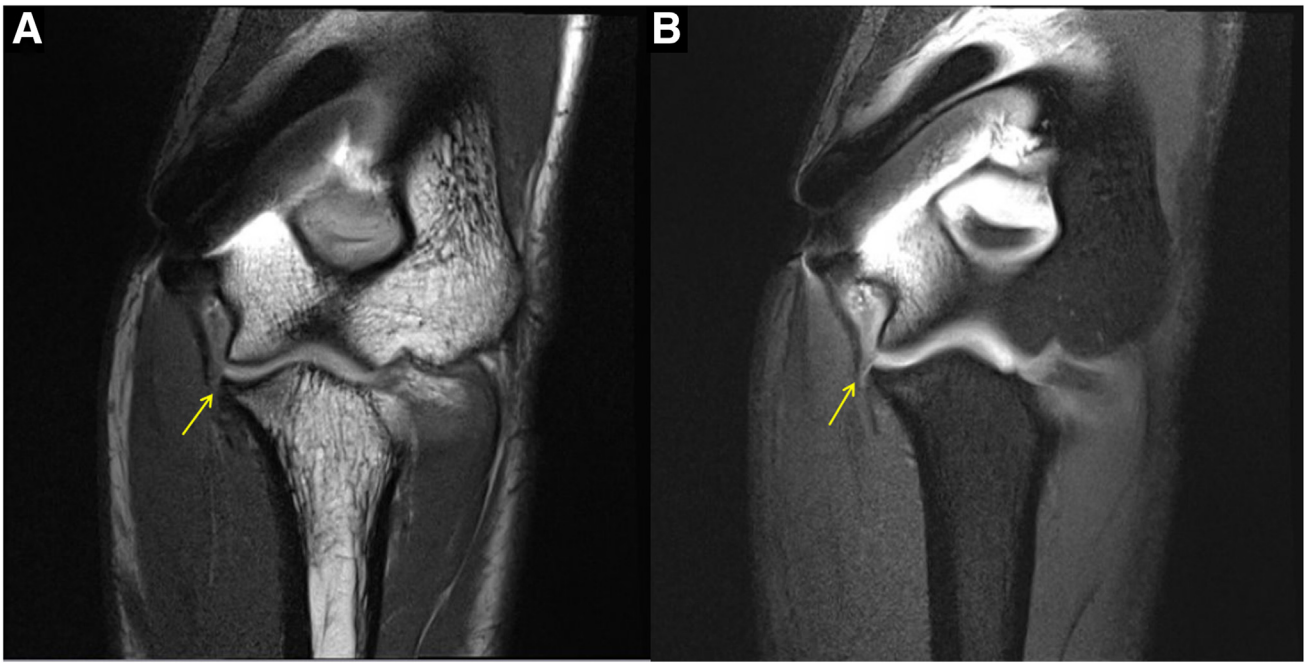

Fig 1. Preoperative magnetic resonance imaging scans illustrating tear (yellow arrow) of ulnar collateral ligament at sublime tubercle in right arm: T1 (A) and T2 (B) coronal images presented in posteroanterior view. (A) The T1-weighted image showcases the detailed morphology of the ligamentous structures, highlighting the tear of the ligament at the sublime tubercle and the extent of the tear. (B) The T2-weighted image emphasizes the fluid contrast, providing additional insight into the injury's characteristics.

holes, and this method is easier to perform. This technique achieves the same biomechanical effect of spanning the joint, thus protecting the repair, and has the potential for a quicker recovery. However, the modification faces limitations, primarily owing to its relatively unproven long-term efficacy compared with traditional reconstruction methods. Additionally, the technique is best suited for acute tears and not chronic

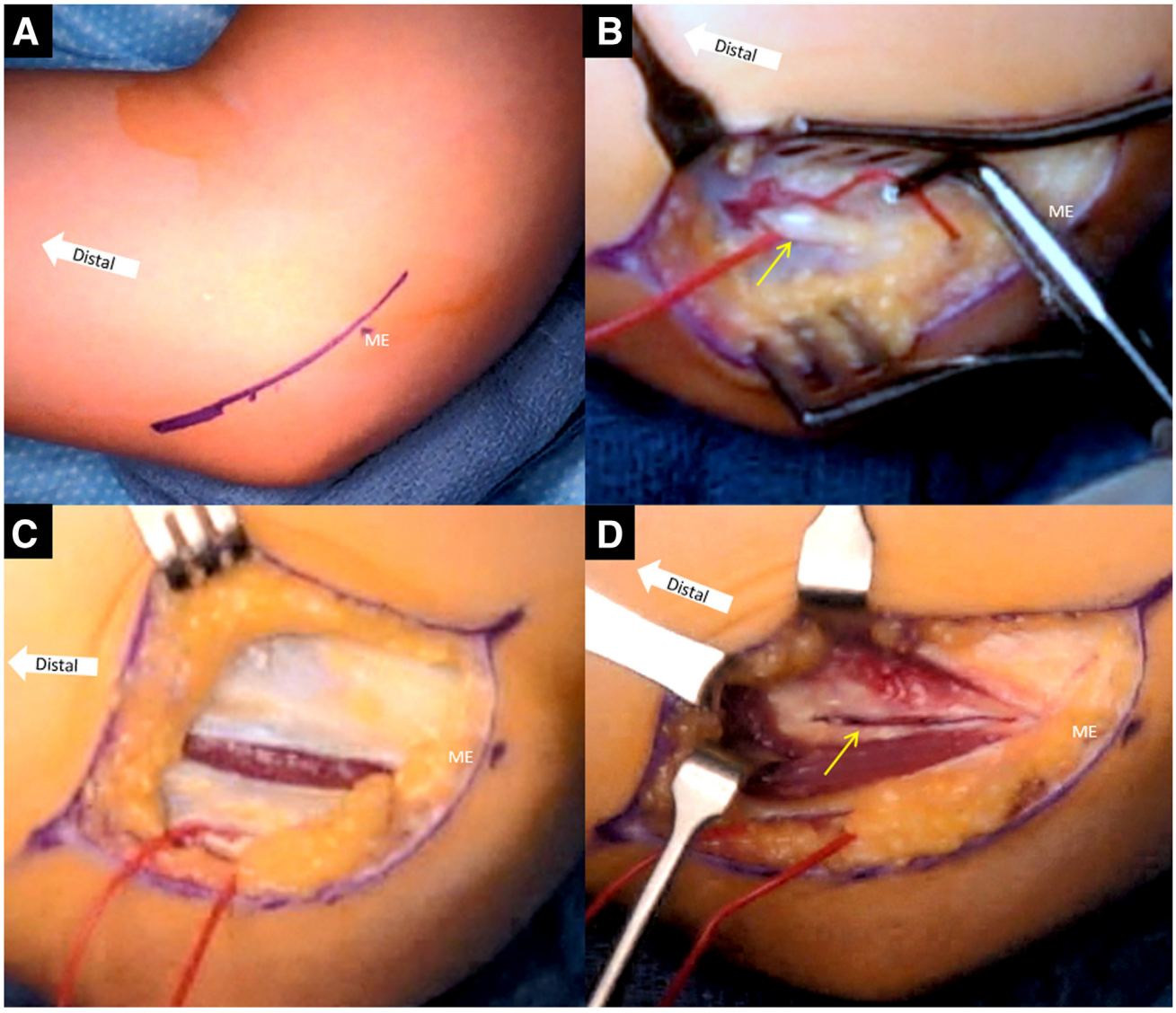

Fig 2. Right elbow, with patient in supine position, illustrating muscle-splitting approach. The medial epicondyle (ME) is labeled for orientation. (A) Relevant anatomic landmarks are marked, including the ME. An incision is made just anterior to the ME and extending distally to the sublime tubercle. (B) The ulnar nerve is isolated at the level of the sublime tubercle. A vessel loop is placed around the ulnar nerve (yellow arrow) to allow for protection and identification of the nerve throughout the procedure. (C) The flexor fascia is split in line with the anterior band of the ulnar collateral ligament (UCL). (D) The muscle is split, and the capsule and the UCL (yellow arrow) are split in line with the anterior band of the UCL.

conditions, with other challenges including the need for activity modification after surgery and potential complications if the internal brace fails (Tables 1 and 2).

Surgical Technique

Indications

In patients with acute UCL tears facing immediate recovery objectives, modified UCL repair with an internal brace using linked knotless suture anchors can be an excellent option. This modified technique offers the potential for quicker rehabilitation than the traditional 12- to 18-month period associated with UCL reconstruction.[11] Suited primarily for acute tears rather than chronic, attritional conditions, the procedure uses smaller, knotless suture anchors and No. 2-0 FiberWire, minimizing the invasiveness of the repair and facilitating easier execution. It achieves the biomechanical benefits of joint spanning, thereby protecting the repair and potentially speeding up recovery. Candidates for this approach should be cognizant of the associated risks and be willing to modify their activities to mitigate postoperative elbow stress.

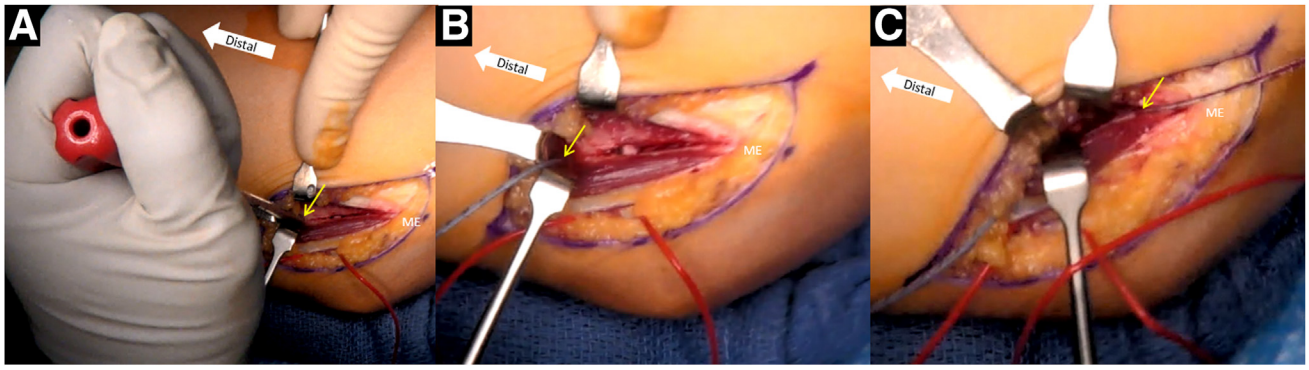

Fig 3. Right elbow, with patient in supine position, illustrating insertion of ulnar and humeral knotless suture anchors. The medial epicondyle (ME) is labeled for orientation. (A) A pilot hole for the ulnar-sided knotless suture anchor is drilled (yellow arrow). (B) A knotless suture anchor is inserted (yellow arrow) adjacent to the sublime tubercle. (C) A second knotless suture anchor (yellow arrow) is placed adjacent to the ME at the humeral insertion.

Imaging Evaluation

The position of a tear (i.e., middle, humeral insertion, or ulnar insertion) in a UCL injury is crucial in determining the appropriate surgical approach. For instance, reconstruction with a graft is often recommended for midsubstance or severe attritional UCL tears. Conversely, tears located at the insertion or origin are potentially amenable to repair (Fig 1). Additionally, large or complex tears potentially require reconstruction with a graft, as opposed to acute tears, which can be treated with repair.

Repair Technique

The patient is given an interscalene block followed by a general anesthetic. The operative upper extremity is then prepared in the usual sterile fashion (Fig 2A). A tourniquet is put in place, and the arm is elevated for about 90 minutes (Video 1).

A medial-based incision just anterior to the medial epicondyle toward the ulna is performed. The soft-tissue flaps are lifted, exposing the medial subcutaneous sensory nerve, which is identified and safeguarded during the procedure. The ulnar nerve is identified proximal to the medial epicondyle and then distally at the level of the sublime tubercle (Fig 2B). Although the ulnar nerve is not exposed, it can be easily palpated and identified clearly throughout the surgical procedure.

Next, the flexor compartment fascia is carefully opened in line with its fibers. The approach through the flexor carpi ulnaris, first published by Smith et al.[12] (1996), is used to take advantage of the internervous plane between the ulnar and medial nerves (Fig 2C). Then, with careful use of a Freer elevator, the muscle is elevated off the medial capsule and medial collateral ligament. Non-sharp handheld retractors are used to assist with exposure. The elbow is taken through a range of motion in medial varus and valgus stress once the ligament is identified, and any tears of the ligament are noted.

After the ligament is split in line with its fibers and the joint is inspected (Fig 2D), a pilot hole is drilled distal to the sublime tubercle (Fig 3A), and a knotless anchor is inserted (Fig 3B). Next, after identification of the UCL's humeral insertion, a pilot hole is placed, and a second knotless anchor is inserted (Fig 3C). After insertion of the knotless suture anchors, a No. 2-0 nonabsorbable suture is used to perform an imbrication in a running locking fashion from distal to proximal for tears off the humeral insertion (Fig 4A). For ulnar-sided UCL avulsions off the sublime tubercle, the No. 2-0 suture is placed from proximal to distal. The repair limb from each suture anchor is shuttled through the opposite suture anchor (Fig 4B). The No. 2-0 suture used for the running locking repair suture is tied to the previously passed tape suture on the ulnar side for additional fixation of the native ligament (Fig 4C). The elbow is again taken through the range of motion and noted to have full motion without restriction.

The wound is irrigated, and a layered closure using Vicryl (Ethicon) and absorbable suture is performed. The patient is placed into a posterior slab splint with a cryotherapy unit incorporated. The patient is then placed into a sling, extubated, and taken to the post-anesthesia care unit for recovery.

Rehabilitation

The rehabilitation protocol involves several phases. Immediately after the operation, the elbow is stabilized in a brace at a 60° to 90° angle to protect the healing tissue and reduce inflammation. Physical therapy begins immediately, focusing on maintaining strength and mobility in the wrist, fingers, shoulder, and biceps to prevent muscle atrophy. At 1 to 2 weeks after surgery, movement of the elbow joint is initiated. The hinged brace can be locked at a specific angle when not exercising; an arm sling may also be worn for comfort. We

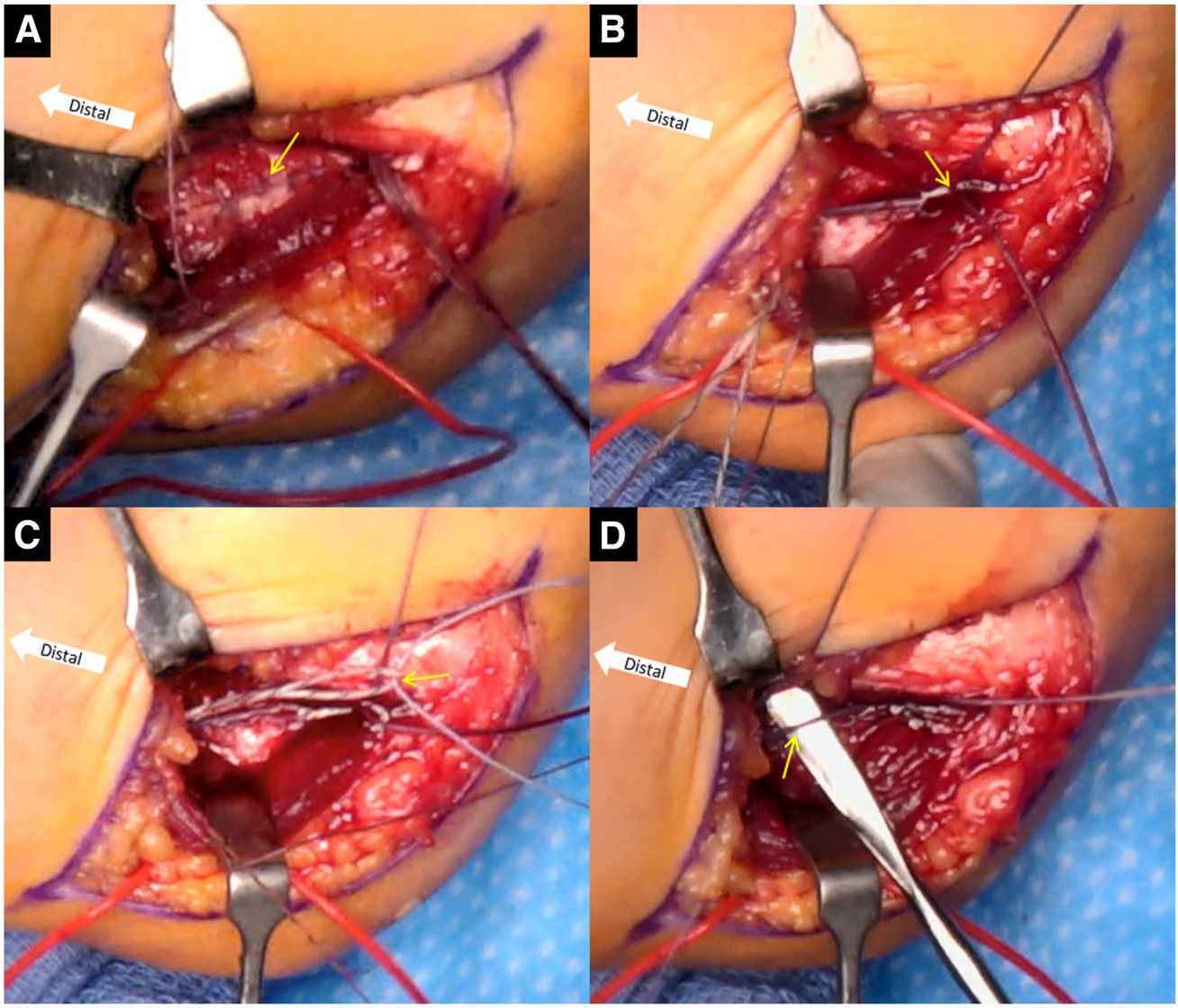

Fig 4. Right elbow, with patient in supine position, illustrating repair of ulnar collateral ligament (UCL). (A) A series of running locking suture passes are made using No. 2-0 nonabsorbable, high–tensile strength braided suture to repair the split in the UCL (yellow arrow). This is performed in a distal-to-proximal fashion because the UCL tear was off the humeral insertion in this patient (for ulnar-sided UCL avulsions off the sublime tubercle, the No. 2-0 suture is placed from proximal to distal). (B) Each limb of the 2 knotless suture anchors is passed through the opposite suture using the shuttling stitch from the opposite anchor. In this case, the distal limb is passed through the proximal knotless suture anchor (yellow arrow), creating the first portion of the repair suture–internal brace construct. (C) The second half of the internal brace–bridging suture construct is created by passing the proximal repair stitch (yellow arrow) through the distal (or ulnar) suture anchor. (D) The sutures are tensioned. A Freer elevator is placed (yellow arrow) to make sure there are no loops or knots and to ensure that the sutures are not over-tensioned.

use the "thrower's ten" program to focus on improving shoulder and elbow stability, strength, and mobility.

Discussion

The knotless anchor UCL repair technique improves the functionality and recovery time of traditional UCL internal brace repair via smaller drill holes and easier insertion. The small No. 2-0 FiberWire suture is essential because it has a lower profile owing to its small diameter and it is less likely to irritate the ulnohumeral joint articular cartilage. The use of a small needle also facilitates suture passage in the small surgical field. This technique can potentially reduce surgical trauma, improve recovery times, and enhance clinical outcomes compared with traditional surgical methods.

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE

author disclosure forms are available for this article online, as supplementary material.

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