Technical Note

Ulnar Collateral Ligament Internal Bracing Repair Technique for High-Grade Partial Proximal Tears in the Throwing Athlete

Benjamin Kerzner, M.D., Daniel J. Kaplan, M.D., Zeeshan A. Khan, B.A., Shelby R. Smith, M.D., Obianuju A. Obioha, M.D., Harry Jawanda, B.S., Garrett R. Jackson, M.D., Varun Gopinatth, B.S., Lakshmanan Sivasundaram, M.D., and Nikhil N. Verma, M.D.

Abstract: The use of ulnar collateral ligament (UCL) repair with concomitant internal bracing for throwing athletes is a viable treatment option, but must take into account tear location, ligament quality, the expected length of the athlete's career, desire to advance to the next level of competition, and age. There has been increased interest in repair of UCL injuries in overhead athletes due to advancements in surgical technique, as well as improved technologies of anchor and suture material. In addition, return to sport can be accelerated compared to reconstruction. In this Technical Note, we demonstrate an ulnar collateral ligament repair technique, with internal bracing augmentation for high-grade partial proximal tears in the throwing athlete that is reliable, strong, and easily reproducible.

Introduction

The elbow joint is highly congruous and achieves stability from bony articulations, ligamentous complexes, and surrounding musculature. Medially, the ulnohumeral joint is supported by the ulnar collateral ligament (UCL), which provides resistance to valgus-directed force. Anatomically, the ulnar collateral ligament is comprised of the anterior, posterior, and transverse bundles.[1,2] Biomechanically, the anterior bundle of the ulnar collateral ligament is strongest and stiffest with a failure load of 260 N and is regarded as the most critical part of the ligamentous complex that contributes to elbow stability.[3] The anterior bundle can be further divided into two parts, with the anterior band providing primary restraint to valgus stress from full extension to 90° of flexion and the posterior component, providing a coprimary restraint at 120° of flexion.[3,4] The role of the posterior bundle is less than that of the anterior counterpart and demonstrates secondary valgus restraint at 30° of flexion.[4] Although the transverse bundle is described, it is variably present, and the structure contributes little to elbow stability as it originates and inserts on the ulna.[5]

Understanding the anatomy and biomechanics of the ulnar collateral ligament is crucial in diagnosing and treating elbow pathology, particularly in overhead-throwing athletes. This patient population places the ulnar collateral ligament complex under repetitive

From Midwest Orthopaedics at Rush, Chicago, Illinois, U.S.A. (B.K., D.J.K., Z.A.K., S.R.S., O.A.O., H.J., G.R.J., V.G., L.S., N.N.V.); and Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, Illinois, U.S.A. (B.K., D.J.K., Z.A.K., S.R.S., O.A.O., H.J., G.R.J., V.G., L.S., N.N.V.)

The authors report the following potential conflicts of interest or sources of funding: N.N.V. reports Dr. Verma reports consulting fees from Minivasive, Orthospace, Smith & Nephew; board or committee membership in the American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association Learning Center Committee, and SLACK Incorporated; stock or stock options in Cymedica, Minivasive, and Omeros; research support from Arthrex, Arthrosurface, DJ Orthopaedics, Ossur, Smith & Nephew, Athletico, ConMed Linvatec, Miomed, and Mitek; royalties from Arthroscopy, Smith & Nephew, Vindico Medical-Orthopedics Hyperguide; and financial or material support from Arthroscopy *and* Vindico Medical-Orthopedics Hyperguide. *Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received February 4, 2023; accepted March 17, 2023.

Address correspondence to Benjamin Kerzner, M.D., Department of Orthopaedic Surgery, Rush University Medical Center, 1611 W Harrison St., Suite 300, Chicago, IL 60612, U.S.A. E-mail: benkerzner@gmail.com

2212-6287/23196

https://doi.org/10.1016/j.eats.2023.03.012

stress, and overuse or single event trauma can result in partial or complete tearing. The biomechanical aspects of the stress placed on the UCL have been well established in the literature and primarily attributed to the valgus overload that occurs during the late cocking and early acceleration phases of throwing.[6,7]

To return patients to similar activity levels as quickly as possible, operative treatments are considered in the form of UCL repair and reconstruction. Although repair is a viable surgical treatment option, the success of the repair is dependent on the type of tear and quality of ligamentous tissue at the time of intervention. The concept of internal bracing has been utilized in other areas of ligamentous reconstruction within the body with success, including deltoid reconstruction of the ankle, lateral ankle ligamentous augmentation for chronic ankle instability, scapholunate ligament for joint instability, and multiligamentous knee injuries.[8-11]

In this Technical Note, we demonstrate an ulnar collateral ligament repair technique with internal bracing augmentation for high-grade partial proximal tears in the throwing athlete that is reliable, strong, and easily reproducible in practice for the operating surgeon (Video 1).

Preoperative Evaluation and Surgical Decision-Making

Evaluation of throwing athletes is complex, and multiple factors must be taken into consideration when determining the optimal treatment plan, which will be highly patient-specific. A thorough history should be obtained, including location of pain, which phase of the throwing motion elicits pain (UCL would be late cocking/early acceleration), nature of the symptoms (loss of control and/or velocity), and ulnar nerve symptoms (nerve subluxation or distal numbness/tingling in the ring or small finger), and patient's current level of play, as well as long-term goals.

Examination focuses on the range of motion (with the understanding that throwers may have a loss of extension), pain to palpation over the proximal or distal origin/insertion of the UCL, or along its midsubstance, pain or instability to valgus stress (particularly at 30°), and presence of ulnar nerve symptoms. Radiographic imaging is typically unremarkable; however, occasionally in chronic cases, small ossicle fragments may be seen around sites of prior avulsions (Fig 1A). Magnetic resonance imaging (MRI) is more helpful, as one can appreciate the ligament throughout its course, and see any midsubstance tears or avulsions. Avulsions may be subtle, and the only evidence on MRI may be a thin layer of fluid between the ligament and its origin/insertion (Fig 1B). This should be corroborated on multiple planes.

Treatment depends largely on the athlete's current severity of symptoms and their goals. In-season athletes with partial tears can typically be treated nonoperatively initially, including a period of rest, following by physical therapy, focusing on strengthening the lower body, core, and musculature supporting the elbow. Anti-inflammatories can also be used to help with both pain and swelling. Biologic injections have been reported with variable levels of success.[12-14] The decision to operate is predicated upon the patient's ultimate goals. Patients that plan to continue to play at elite levels (college or professional) should be more strongly considered for surgical intervention. High school athletes with no plans to play competitively in the future (particularly if symptoms are mild, such as only a small loss of velocity) should have extensive nonoperative therapy before surgery should be considered.

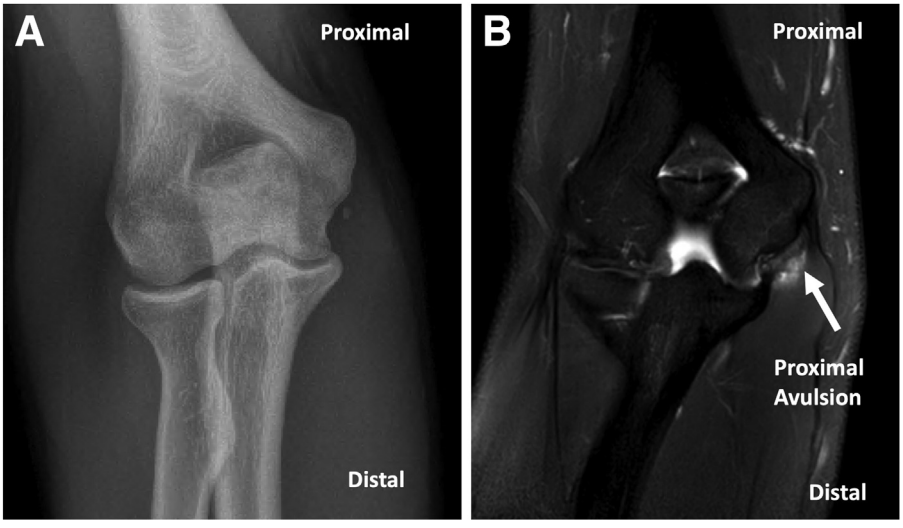

Fig 1. Preoperative imaging of the right elbow. (A) Anteroposterior view of the elbow with good joint space and evidence of a small bony avulsion to the medial epicondyle consistent with the location of pain. (B) Magnetic resonance imaging without contrast in the coronal T2 view of the right elbow with high-grade partial proximal tear of the medial ulnar collateral ligament.

If the decision to operate is made, the question of repair versus reconstruction will ultimately be made at surgery depending upon tissue quality. Patients most amenable to repair include those with proximal or distal avulsions, with the substance of the ligament otherwise intact. It is the senior author's preference to schedule and consent all potential repairs as possible reconstructions, including possible graft harvest.

Patient Positioning and Anesthesia

The patient is placed supine on a standard operating room table with a hand table attachment (Fig 2A). Both the operative arm, as well as the ipsilateral lower extremity are prepped and draped in case the native UCL is not found amenable to repair, and a reconstruction is performed (it is the senior author's preference to use a gracilis autograft in cases of reconstruction). A sterile tourniquet is applied to the arm, as high up in the axilla as possible to avoid encroachment on the operative field. A stack of blue towels is placed underneath the elbow.

Surgical Technique

Relevant anatomical landmarks are marked out, including the medial epicondyle (ME). A curvilinear incision is made just posterior to the ME, extending about 1 cm proximal to it, and 4-5 cm distal to it (Fig 2B). Sharp dissection is performed through the underlying subcutaneous tissue, with care to identify and protect any branches of the medial antebrachial cutaneous nerve (MABC), which is commonly encountered in the distal aspect of the incision. The nerve is typically superficial, and anterior to the ME, so dissection posterior to the ME helps reduce iatrogenic risk. At this point, if the patient had any ulnar nerve symptoms or subluxation, a decompression can be performed with later consideration for

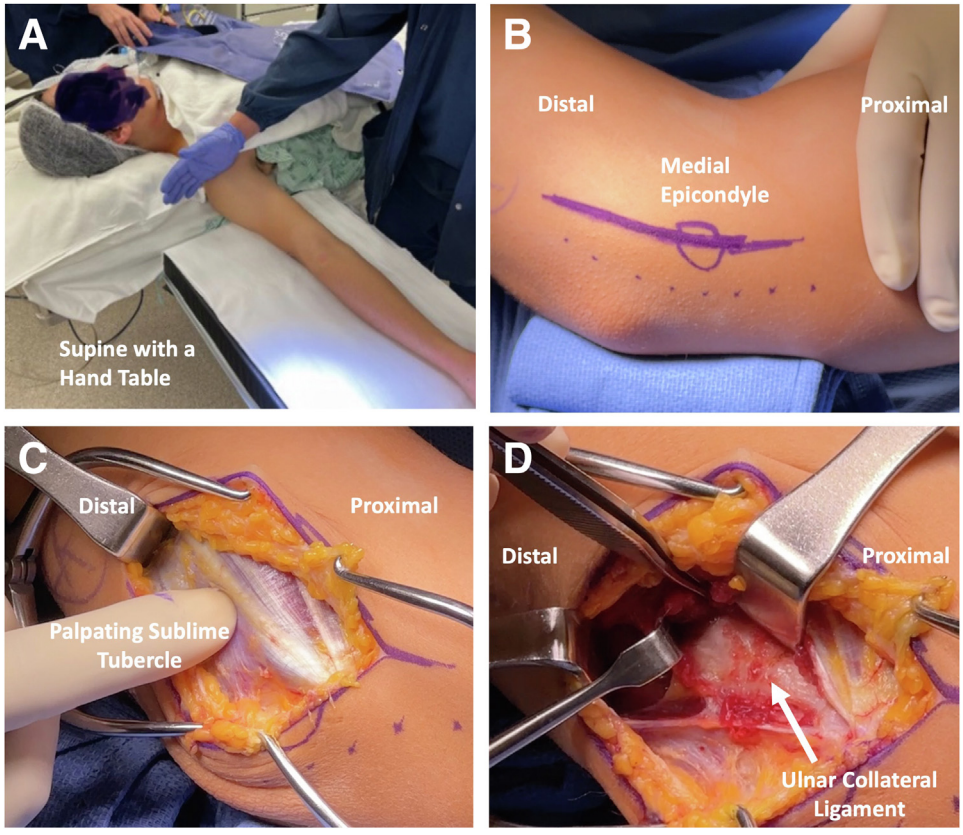

Fig 2. Patient positioning and initial dissection of the right elbow. (A) The patient is placed supine on a standard operating room table with a hand table attachment. A sterile tourniquet is applied to the arm, as high up in the axilla as possible to avoid encroachment on the operative field. A stack of blue towels is placed underneath the elbow. (B) Relevant anatomical landmarks are marked out, including the medial epicondyle (ME). A curvilinear incision is made just posterior to the ME, extending about 1 cm proximal to it, and 4-5 cm distal to it. (C) The sublime tubercle is palpated and the fascia overlying the flexor-pronator mass is then opened, and the flexor carpi ulnaris (FCU) is split through a raphe along its posterior third, and dissection is carried down sharply to the underlying ulnar collateral ligament (UCL) tissue. (D) The UCL will appear as a thick band of white tissue immediately under the flexor-pronator mass.

transposition if instability is noted through range of motion.

The fascia overlying the flexor-pronator mass is then opened, and the flexor carpi ulnaris (FCU) is split through a raphe along its posterior third, and dissection is carried down sharply to the underlying UCL tissue (Fig 2C). The UCL will appear as a thick band of white tissue immediately under the flexor-pronator mass (Fig 2D). The ligament is then exposed from its origin on the antero-inferior aspect of the ME to its insertion on the ulnar ridge of the sublime tubercle. One way to identify the sublime tubercle is to palpate the ulnar ridge distally and trace this proximally to the teardrop-shaped sublime tubercle. The ligament is then inspected, and the decision to repair versus reconstruction is revisited. For cases in which the tissue is found to be in continuity, but with some degeneration, primarily around its proximal attachment, the decision is made to repair the ligament. Great care is taken to protect the ulnar nerve in the posterior portion of the FCU.

The ligament is then split in line with its fibers, exposing the ulnohumeral joint (Fig 3A). Medial gapping can be appreciated (the blue towels under the elbow apply a valgus stress moment to the elbow) (Fig 3B). An opening more than 1 mm is considered abnormal. The native ligament is then debrided of any degenerated tissue. This debridement should be focused on the location of the tear based on both dissection, as well as preoperative MRI, where either an origin or insertion avulsion may be appreciated. A small self-retaining retractor can be placed to retract the anterior and posterior portions of the ligament, as well as the FCU.

The first anchor is placed at the site of the ligamentous avulsion, in this case the ME, as this will be repaired with the loaded anchor. A pilot hole is then

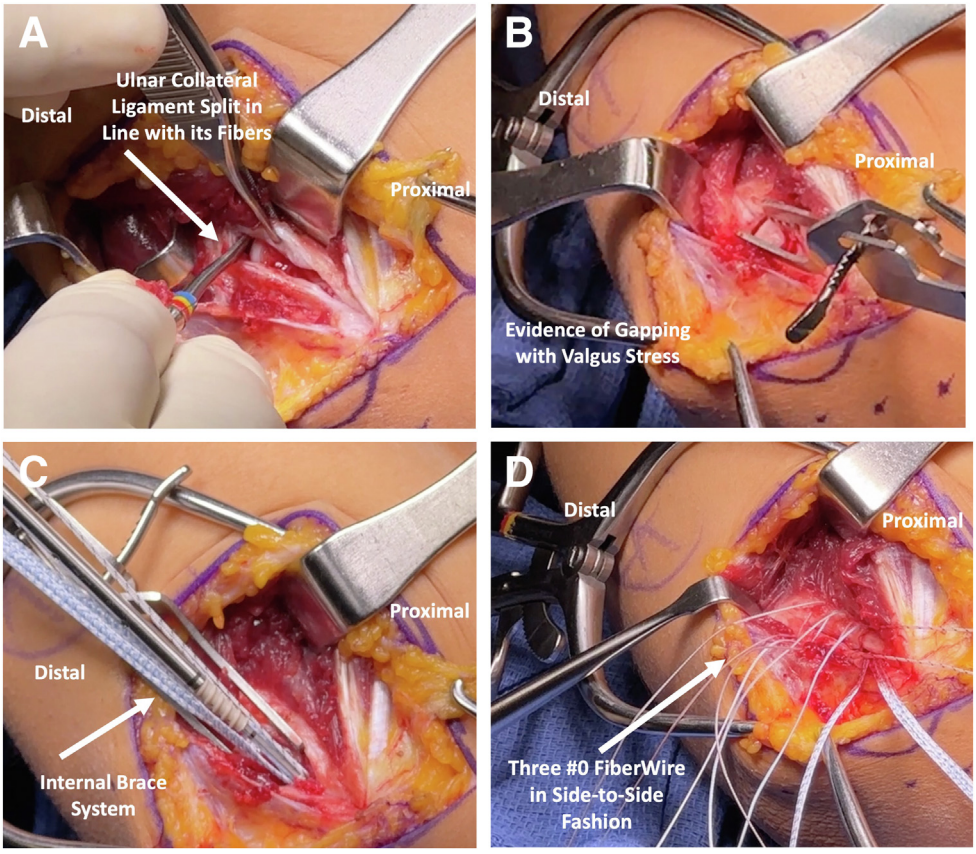

Fig 3. Proximal anchor placement and repair of right elbow ulnar collateral ligament proximal tear. (A) The ligament is split in line with its fibers, exposing the ulnohumeral joint. (B) Medial gapping can be appreciated while a valgus stress moment to the elbow is applied. The native ligament is then debrided of any degenerated tissue. (C) A 3.5-mm PEEK SwivelLock anchor from the ulnar collateral ligament internal brace system is then placed, which contains both a collagen-dipped suture tape, as well as a #0 FiberWire repair suture. The repair suture is passed through the proximal portion of torn ligament complex in a figure-of-eight configuration to repair the avulsed ligament back to its origin on the medial epicondyle. (D) The remainder of the ligament is then closed with #0 FiberWire in a side-to-side fashion. Once all the sutures are passed, the joint is reduced with a varus force on the elbow, and the proximal repair sutures are tied, followed by the side-to-side FiberWire sutures.

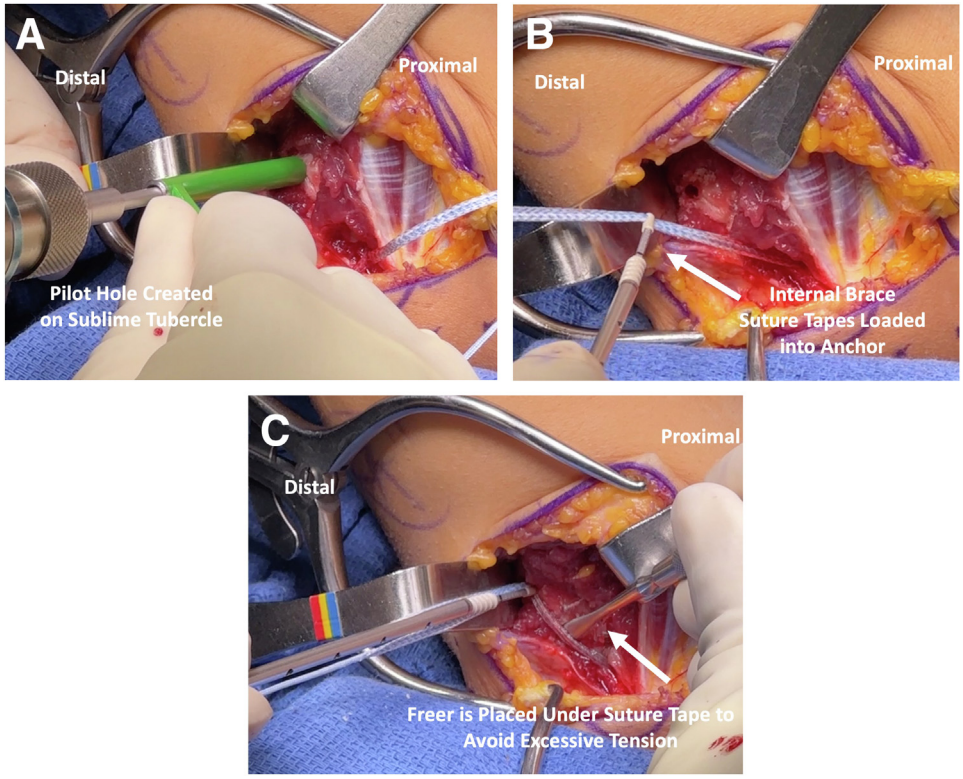

Fig 4. Distal anchor placement and tensioning of internal bracing system of right elbow. (A) A second pilot hole is then created on the sublime tubercle, ~8-10 mm distal to the joint line in the center of the sublime delineated by the ulnar ridge. (B) The ulnar collateral ligament internal brace FiberTapes are loaded into a 3.5 mm PEEK SwiveLock anchor. This anchor is then advanced into the drilled hole on the sublime tubercle with the elbow in varus and 30° of flexion. (C) While the anchor is advancing, a freer is placed under the FiberTape to avoid excessive tensioning.

made at the base of the ligament origin on the ME using a 2.7-mm drill, then tapped with a 3.4-mm tap. A guidewire with a cannulated drill can be used to estimate the drill placement more anatomically. A 3.5-mm PEEK SwivelLock anchor from the UCL internal brace system (Arthrex, Naples, FL) is then placed, which contains both a collagen-dipped suture tape, as well as a #0 FiberWire (Arthrex, Naples, FL) repair suture (Fig 3C). The repair suture is passed through the proximal portion of torn ligament complex in a figure-of-eight configuration to repair the avulsed ligament back to its origin on the ME. The remainder of the ligament is then closed with #0 FiberWire in a side-to-side fashion. It is helpful to pass all sutures first prior to tying, as this will close down the space and impede visualization (Fig 3D). Once all the sutures are passed, the joint is reduced with a varus force on the elbow, and the proximal repair sutures are tied, followed by the side-to-side FiberWire sutures.

A second pilot hole is then created on the sublime tubercle, ~8-10 mm distal to the joint line in the center of the sublime delineated by the ulnar ridge (Fig 4A). This is made using a 2.6-mm drill and a 4.2-mm tap, again for a 3.5-mm anchor. The UCL internal brace FiberTapes are loaded into a 3.5-mm PEEK SwivelLock anchor (Fig 4B). This anchor is then advanced into the drilled hole on the sublime tubercle with the elbow in varus and 30° of flexion. Although the anchor is advancing, a freer is placed under the FiberTape to avoid excessive tensioning (Fig 4C). The elbow is then taken through a range of motion, confirming appropriate tension and full mobility without ROM limitation (Fig 5A).

The FCU split is then closed using simple interrupted 1-0 Vicryl sutures (Fig 5B), and the wound is subsequently closed with a 2-0, and then a 3-0 Monocryl suture. A posterior mold split is applied, which is kept in place for 7-10 days before any range of motion is initiated.

Rehabilitation

In the first 4 weeks postoperatively, passive range of motion is emphasized with progression of active assist range of motion to active range of the motion with the goal of 10-125° range of motion by week 3. There is focus on scapular and isotonic strengthening with no lifting allowed during this acute phase of rehab. From weeks 4 to 8, there should be further progression in the Thrower's Ten program followed by elbow and wrist strengthening.[15] At 8-10 weeks, incorporation of one hand plyometric and prone planks. Seated machine bench press and interval hitting program for baseball/softball athletes can be initiated by week 10. During weeks 11-16, an interval throwing program (phase 1)

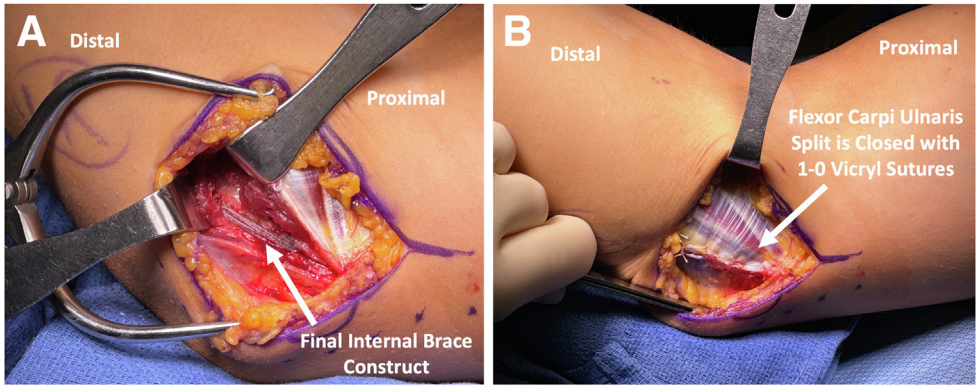

Fig 5. Final internal bracing construct and deep closure of right elbow. (A) The final construct is inspected, and the elbow is then taken through a range of motion, confirming appropriate tension. (B) The flexor carpi ulnaris split is then closed using simple interrupted 1-0 Vicryl sutures, and the wound is subsequently closed with the 2-0, and then the 3-0 Monocryl suture.

with progression to long toss should be initiated. At weeks 16-20, phase 2 of an interval throwing program can be started followed by mounding throwing when ready.

Discussion

When these medial sided elbow injuries do occur, altered throwing mechanics, high pitch counts, and associated fatigue are contributors to pathology of the UCL.[16] Like most orthopaedic injuries, treatment includes both nonoperative and operative options. Preferentially, a period of nonoperative rest, bracing, anti-inflammatory medications, and stretching followed by progressive strengthening and return to throwing programs are recommended for UCL injuries. Outcome studies for nonoperative treatment are limited, and one study reported that only 42% of patients returned to the same athletic level.[17] UCL reconstructions have increased substantially in the adolescent population, with the rate nearly tripling over a 10-year period.[18] It has also been noted that a higher incidence of pitchers undergo UCL reconstructions compared to nonpitchers, primarily linked to overuse.[19-21] There has been an increased interest in repair of UCL injuries in overhead athletes due to advancements in surgical technique, as well as improved technologies of anchor and suture material.[22-25]

Bodendorfer et al. compared load to failure, gapping, and valgus opening angle of repair with internal bracing and reconstruction with the docking technique. The authors found that no significant differences were found in any of those variables during cyclic loading at initial time of surgery.[26] Furthermore, Jones and colleagues assessed the differences in fatigue and failure mechanics for repair with internal bracing compared to traditional reconstruction with increasing amount of repetitive stress.[27] They found that during valgus stress at the 10th, 100th, and 500th cycle of loading, the repair with internal bracing group experienced less gapping compared to the reconstruction group. Both UCL reconstruction with a modified Jobe approach and repair with internal bracing have shown to restore torque and contact pressures similar to the native state of the elbow joint.[28]

While fixation methods vary, the ultimate goals of reconstruction remain consistent and include a reconstruction that is isometric to the native ligamentous complex, biomechanically sound to withstand repetitive valgus loads, and has high healing potential and low complication profile.[29-31] UCL repair has been reported as a surgical alternative and is a viable option in young athletes, with 97% of patients returning to preinjury competition level at 6 months.[32] Dugas et al. further confirmed these findings when they prospectively followed 111 overhead athletes at their institution who underwent UCL repair with internal bracing.[33] In this cohort, 92% of patients were able to compete at the same or higher level of

Table 1. Pearls and Pitfalls

Pearls
• Keeping incision and dissection posterior to the medial epicondyle helps to reduce iatrogenic risk to medial antebrachial cutaneous nerve.
• Sublime tubercle may be identified by palpating the ulnar ridge distally, then tracing it proximally to the tubercle.
• Place a small self-retaining retractor that can retract the anterior and posterior portions of the ligament, as well as the flexor carpi ulnaris.
• Place a freer under the FiberTape while advancing the internal brace anchor to avoid overtensioning
• Patients should be placed in a posterior mold immediately after surgery for the first 7-10 days prior to initiating range of motion of the elbow.
Pitfalls
• Not protecting the ulnar nerve at all times, as it may sit much more anteriorly than anticipated, which can result in iatrogenic damage
• Tying sutures prior to passing all repair stitches, as this will close down the space and impede visualization
• In cases where the tissue is found to be in moderate to severe degeneration, the decision to repair the ulnar collateral ligament should be avoided due to a weak overall construct with internal bracing.

competition 6.7 months after surgery with a Kerlan Jobe Orthopaedic Clinic mean score of 88.2 at final follow-up. They also found no differences in outcomes when the tear was proximal versus distal or complete vs partial.

The use of UCL repair with concomitant internal bracing for throwing athletes is a viable treatment option but must take into account the expected length of the athlete's career, desire to advance to the next level of competition, tissue quality, and age.[34] From a therapy perspective, repair with internal bracing follows a more rapid protocol than reconstruction, with full range of motion expected by week 4.[35] The largest differences in therapy between the two operative methods is the earlier initiation of interval training and return to throwing activities for those undergoing repair with internal bracing.[35] Table 1 describes the pearls and pitfalls of the currently described technique. Given the high incidence of UCL injuries in overhead-throwing athletes across all age groups, it is imperative that treating surgeons understand the patients' goals and appropriately select patients for UCL repair with concomitant internal bracing.[19,36]

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