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Elbow ulnar collateral ligament reconstruction using suture tape augmentation

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A R T I C L E I N F O

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Tendon allograft
UCL reconstruction

Improvements in the quality of diagnostic imaging and the growing population of throwing athletes have both led to an increase in the reported incidence of ulnar collateral ligament (UCL) injuries of the elbow. There has also been a subsequent increase in UCL reconstructions, especially in adolescents owing to early 1-sport specialization and year-round throwing.[4,5] Return-to-play and complication rates, especially those related to ulnar nerve issues, have significantly improved from the earliest reports of UCL reconstruction to more modern techniques. Initial reports of UCL reconstruction using the Jobe technique noted more than 60% rate of return to play at an equal or higher level of participation; however, the rate of complications reached up to 50%.[14] More recent results using the modified Jobe and docking techniques, among others, have demonstrated return to play rates of up to 90% and complication rates of less than 5%.[3,8,17] Despite having successful outcomes with a wider variety of techniques, there is a paucity of comparative clinical data regarding the optimal method for UCL reconstruction and no level-1 data to support the superiority of one technique over another.

A novel approach to treating ligament injuries is the concept of augmenting repair with a spanning suture bridge anchored on each end of the ligament's insertion to bone. Biomechanical cadaveric studies comparing UCL repair with internal bracing and modified Jobe reconstruction have demonstrated favorable results with less gap formation at low cyclic and fatigue loads and no significant differences in time-zero failure strength.[10,15] The authors propose this method of repair to be a potentially viable option for younger patients in cases of acute proximal or distal UCL insertion injuries. Another biomechanical study compared UCL repair with internal bracing with the docking technique and found no difference in load to failure and valgus opening angle and concluded that bracing may provide stability during ligament healing and maturation.[2] In a clinical study, Dugas et al[9] performed UCL repair with collagen-dipped suture bridge augmentation in overhead athletes and found a 92% return to sport and shortened time to return (6.7 months) compared with UCL reconstruction. An accelerated rehabilitation program may be appropriate for patients who are compliant and desire to return to a higher level of competition.

While UCL repair has demonstrated a high return to sport with young athletes with acute proximal or distal tears, it may not be suitable for midsubstance or attritional tears.[22] For athletes and individuals with chronic microtrauma and evidence of ligament attenuation, a repair attempt may be futile and a graft-type reconstruction is often necessary. A UCL reconstruction of the elbow using a soft-tissue graft in combination with an internal brace has not yet been described and is what is highlighted in this technique article. Advantages include the following: (1) the ability to augment a reconstructed ligament to minimize any early gap formation and (2) the placement of one bony socket at each end of the graft, in the humerus and ulna, which can prevent tunnel-related fractures. This article will highlight several anatomic considerations and indications for using this technique, a detailed description of the technique and its postoperative regimen, and the complications and pitfalls that may be associated with its use.

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Anatomic considerations

The goal of UCL reconstruction is to restore the stability, anatomy, and biomechanics of the elbow. The anterior bundle of the UCL provides the main restraint to valgus stress at 30° to 120° flexion. Cadaveric studies have described the origin of this ligament to have a mean footprint of 45.5 mm^2 on a flat portion of the humerus, 13.4 mm anteroinferior to the most prominent portion of the medial epicondyle.[11,13] The ligament spans an average length of 53.9 mm distally and has a central insertion onto the sublime tubercle that is 7.3 mm distal to the joint line. It inserts onto a wide footprint, measuring 127.8 mm^2 and has fibers extending distally along the ulnar ridge. Understanding these anatomic points and relationships is crucial in surgically recreating elbow stability while maintaining range of motion (ROM). In cases of ligament injury where the location of the origin or insertion can be difficult to determine, these measurements may serve to be useful in the accurate and anatomic placement of bone tunnels during reconstruction. Several dynamic stabilizers of the medial elbow insert just adjacent to or even on the UCL's ulnar footprint. The ulnar head of the flexor digitorum superficialis inserts on the radial aspect of the anterior bundle of the UCL, 11.3 mm distal to the joint line, and spans 45.6% of the total length of that bundle. The tendinous insertion of the flexor carpi ulnaris (FCU) attaches near the sublime tubercle, 4.2 mm from the joint line and 1.7 mm posterior to the ulnar ridge, and overlaps 20.9% of the UCL's anterior bundle. Knowing this anatomic relationship between the static and dynamic stabilizers of the medial elbow can help limit dissection and further destabilization of the medial elbow.

Indications

The indication for reconstruction is valgus instability, as a result of a complete tear or severe attenuation of the anterior bundle of the UCL, which is documented by positive findings on the history, physical examination, and magnetic resonance imaging (MRI) in an athlete with a determination to return to sport.[12,16,19] Athletes with partial thickness tears, as visualized on MRI, are also candidates for surgery if symptoms are recalcitrant to 3 months of nonoperative treatment.[7,18,20]

Surgical technique

The patient is positioned supine with the arm abducted 90° on a hand table. A nonsterile, well-padded tourniquet is placed high on the arm. A 6-cm longitudinal incision is made, centered over the ulnohumeral joint, just anterior to the medial epicondyle and heading distally toward the sublime tubercle. While an assistant holds the arm externally rotated and the elbow slightly flexed, dissection is carried down to the level of the flexor-pronator fascia, taking care to protect the branches of the medial antebrachial cutaneous nerve. In patients without ulnar nerve symptomatology, an in situ release of the nerve at the cubital tunnel is performed for visualization and protection during the placement of the suture anchors. If the patient experiences symptoms of cubital tunnel syndrome preoperatively, a subcutaneous transposition of the ulnar nerve is performed after the reconstruction, and a fascial sling is used to prevent its subluxation posteriorly. After cubital tunnel release, an incision is made into the posterior third of the FCU fascia, in line with its muscle fibers. A small curved clamp is used to bluntly spread the fibers to get down onto the sublime tubercle. Retracting the flexor-pronator mass anteriorly, the insertion of the anterior bundle of the UCL is visualized and the periosteum elevated off the sublime tubercle, taking care to limit this dissection and not release the FCU and flexor digitorum superficialis tendinous origins (Fig. 1). The joint capsule is incised to visualize the joint line for bony landmark referencing, facilitating anatomic ulnar anchor/graft placement relative to the sublime tubercle and joint line. A palmaris longus or semitendinosus tendon allograft is prepared on the back table. The graft is contoured to a 3-mm diameter and whipstitched on both ends using a No. 2 looped suture. The graft along with a 1.3-mm SutureTape and a No. 0 suture is loaded into a 4.75 x 14-mm forked tip, fully threaded, twist-in, knotless suture anchor, as shown in Figure 2 (Arthrex Inc., Naples, FL, USA).

Figure 1 Intraoperative photo demonstrating the exposure of the sublime tubercle through an FCU split approach. *FCU*, flexor carpi ulnaris.

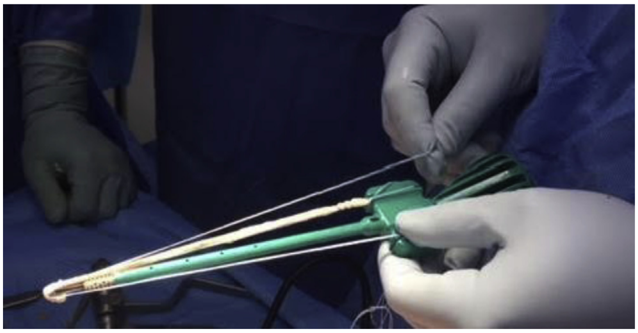

Figure 2 Intraoperative photo depicting loading of the forked tip, fully threaded, twist-in, knotless suture anchor with palmaris longus allograft, FiberWire, and SutureTape (Arthrex Inc., Naples, FL).

A 16-mm bony socket for the anchor is made using a 5.0-mm drill bit, aimed slightly proximal, posterior, and lateral to the apex of the sublime tubercle. This socket is slightly longer and wider than the anchor to accommodate the extra bulk when loaded with the graft and suture. The loaded anchor is then inserted, as shown in Figure 3, *A* and *B*. The graft is overwrapped in a moist lap sponge as attention is next focused on the proximal ligament insertion. The native origin of the anterior bundle of the UCL is palpated in the axilla of the medial epicondyle, 13 to 14 mm anteroinferior to the most prominent aspect of the medial epicondyle. While protecting the ulnar nerve posteriorly and ulnarly, the periosteum overlying this native origin is elevated and another 16-mm bony socket is drilled up the medial column of the humerus with a 5.5-mm drill bit. A second 4.75 × 14-mm, forked-tip, fully threaded, twist-in, knotless suture anchor, loaded with the SutureTape, No. 0 suture, and the graft is inserted into the socket, as shown in Figure 4, *A* and *B*. During this step, the elbow is kept in 45° flexion, while a varus force is applied and firm tension is held on the graft. The excess graft is doubled over onto itself for the length of the reconstructed ligament and sutured together with nonabsorbable No. 0 suture. The No. 0 suture from each anchor is used to repair any native ligament, given a stout remnant is visualized. The remainder of the excess graft and sutures are cut. The FCU fascia is repaired using No. 0 Vicryl Suture. The tourniquet is then deflated and hemostasis is achieved. The wound is then copiously irrigated and closed in a layered fashion.

Postoperative management

A posterior splint, with the elbow in 90° of flexion, is placed in the operating room and removed 7 to 10 days after surgery at the first postoperative visit. The patient is encouraged to perform active wrist and hand ROM as well as hand gripping exercises during this time. At the first visit, the splint is replaced with a hinged elbow brace, locked at 30 to 100° of flexion, and elbow ROM is initiated. Submaximal isometric strengthening exercises are performed for the shoulder and arm musculature making sure to avoid external rotation at the shoulder. During the third postoperative week, the brace is adjusted to allow 15° to 110° of motion. This is followed by an incremental increase of 5° of extension and 10° of flexion every week thereafter. By postoperative week 6, the brace is adjusted to 0° to 130° ROM and active ROM out of the brace is permitted from 0° to 145°. Within this time period, a progressive isotonic resistive exercise program is initiated, focusing on scapular, rotator cuff, elbow, and wrist musculature. The hinged elbow brace is discontinued 9 weeks after surgery at which point a sport-specific rehabilitation program can be initiated. Stretching and flexibility exercises are continued to restore full elbow, shoulder, and wrist ROM. The Thrower's Ten Exercise Program is encouraged along with a plyometric exercise program and manual resistance diagonal patterns. For pitchers, an interval-throwing program is begun at 3 months postoperatively, given that all motion, strength, and

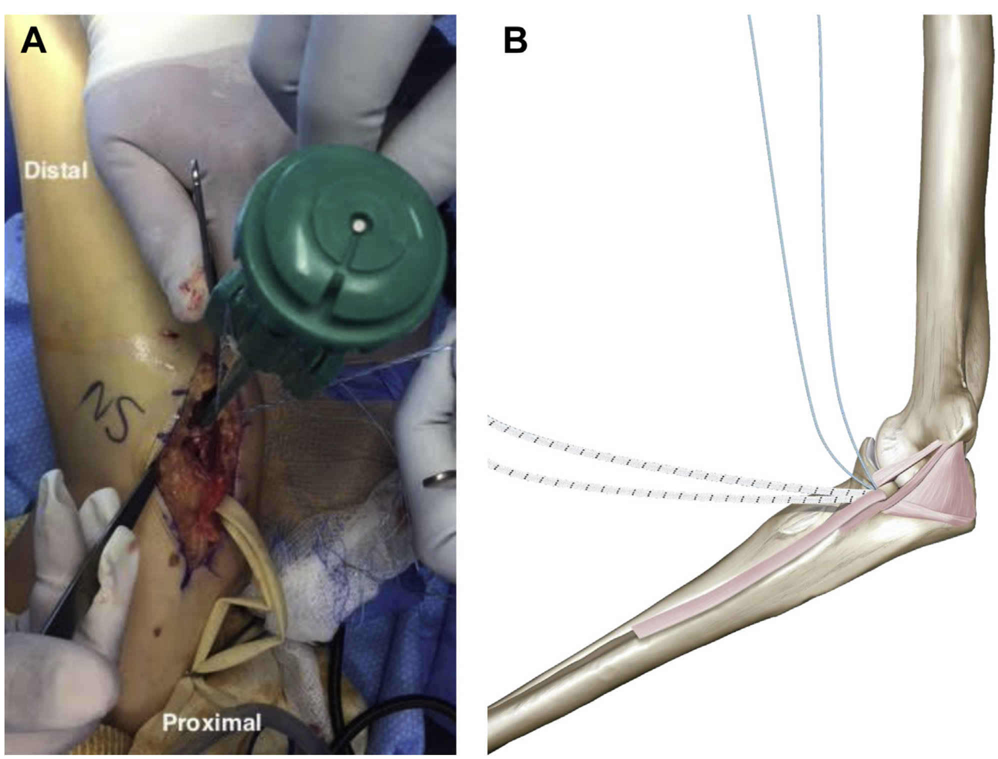

Figure 3 (**A, B**) Intraoperative photo and illustration showing placement of the loaded anchor into the bony socket created within the sublime tubercle.

Figure 4 (**A, B**) Intraoperative photo and illustration demonstrating secure placement of the second anchor, loaded with the graft and SutureTape, into the UCL origin on the humerus. *UCL*, ulnar collateral ligament.

endurance parameters are met. Return to competitive throwing can be expected 6 to 9 months postoperatively.

Pearls, pitfalls, and complications

One of the main complications related to most reconstruction techniques is ulnar nerve neuropraxia. Our technique minimizes handling of the nerve, given no transposition is required based on preoperative symptoms. It also limits dissection of the flexor-pronator mass by only splitting the fascia and underlying fibers and avoiding detachment of the muscle from its origin. An established complication of the modified Jobe as well as the original docking and modified docking techniques is bony failure that can occur in the form of medial epicondyle avulsion fractures and ulnar tunnel fractures.[3,17,21] A contributor to bony failure may be placement of multiple bone tunnels in both the ulna and humerus. The technique presented here avoids the technically demanding placement of multiple converging tunnels by drilling only one 5.0-mm bony socket in the ulna and a second 5.5-mm bony socket in the humerus, with the goal of minimizing bony failure. These socket diameters are similar in size to recently described techniques that incorporate interference screw fixation and clinically have not demonstrated issues related to bony failure.[6] These single bony sockets take a more cautious approach to the limited bone availability of the humerus and ulna in comparison to other techniques that involve multiple smaller drill holes but overall combined tunnels diameters greater than 5.0 mm or 5.5 mm.[3,8,17] Other advantages to single bony socket placement include more limited surgical dissection for anchor entry and the ability to recreate the most isometric and central fibers of the ligament. This helps restore normal kinematics for the entire range of flexion and extension as demonstrated by prior biomechanical work on the interference screw technique.[1]

The surgical technique illustrated provides an approach that minimizes ulnar nerve handling similar to modern techniques. Furthermore, the technique aims to minimize the technical challenges and potential complications associated with multiple tunnel creation with a single bony socket in both the ulna and humerus. The technique incorporates the benefits of a UCL reconstruction with the check reign security of an internal brace suture augmentation. Larger clinical studies with longer follow-up are needed with this technique to appropriately compare with existing techniques. We acknowledge that the combination of techniques may be best reserved for patients with (1) a strong desire to return to a higher level of competition and (2) are willing and able to potentially undergo an accelerated rehabilitation program. Adhering to these indications may justify the potentially increased costs of the procedure.

Case illustration

A seventeen-year-old right hand dominant, male pitcher presented to clinic for evaluation of a 1-month history of isolated right medial elbow pain and intermittent numbness along the 5th finger. He was a starting pitcher for his high school team and noted an increase in his pitch count during that time. He has plans to compete at the next level in college as a starting pitcher. An MRI was obtained and revealed a midsubstance complete tear of the UCL. On physical examination, his elbow was painful and unstable to valgus stress. There was a positive Tinel's sign over the cubital tunnel. Subluxation of the ulnar nerve over the medial epicondyle was also noted. There was no weakness or sensory deficits in the ulnar nerve distribution. Owing to the midsubstance nature of the tear and his desire to return to a higher level of competitive activity, he was indicated for UCL reconstruction over UCL repair. Given the success of suture bridge augmentation in UCL repair and nonelbow ligament reconstruction augmentation, we felt he would benefit from UCL reconstruction with suture bridge augmentation. He underwent the surgical technique described previously using a palmaris longus tendon allograft in addition to subcutaneous ulnar nerve transposition. Intraoperatively, he exhibited degenerative attenuation of the UCL, further supporting our indication for reconstruction rather than repair. His postoperative course included an interval throwing program which allowed him return to play 9 months after surgery. On his most recent postoperative visit, 11 months after surgery, he demonstrated excellent elbow ROM from 3 to 145° of flexion (Figure 5, *A* and *B*). He demonstrated full pronosupination of the forearm. There was no tenderness over the medial elbow and he was stable to valgus stress. There were no sensory or motor deficits along the ulnar nerve distribution. Grip and pinch strength were both equal to the contralateral, unaffected side (Jamar Hand Dynamometer and Pinch Gauge). A quickDASH score of 0 was obtained. He returned to pitching for his high school at the same level of competition and noted feeling stronger than his preinjury state.

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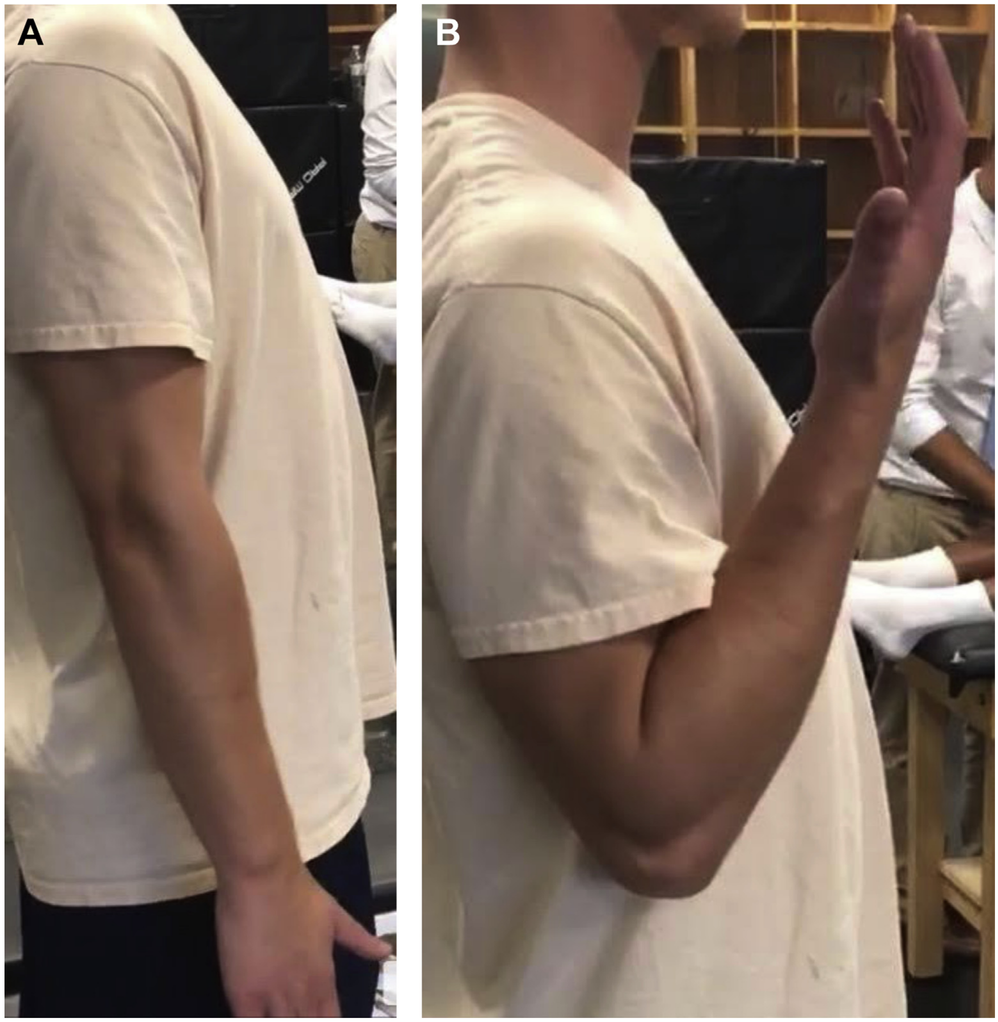

Figure 5 (**A, B**) Clinical photos 11 months after surgery demonstrating the patient's maximum extension and flexion.

Conflicts of interest

Steven J. Lee and Benjamin B. Bedford are consultants for Arthrex Inc. and receive royalties. The other authors, their immediate family, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Patient consent

Obtained.

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