

# Ulnar Collateral Ligament Reconstruction Technique Utilizing Suture Tape Augmentation



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**Abstract:** The prevalence of ulnar collateral ligament injuries and reconstructions among overhead throwing athletes has significantly risen in recent years. Surgical reconstruction has become the main treatment modality for athletes who have failed conservative treatment and wish to return to their sport. There has been an increased interest in graft augmentation in ligament reconstruction surgeries as surgeons search for ways to decrease the chance of graft failure. Augmented graft techniques have been described for other procedures. We present a technique that incorporates a cross-linked suture tape into either a palmaris longus or gracilis tendon autograft or allograft for ulnar collateral ligament reconstruction. This may allow for a biomechanically stronger construct because it appears this is the case in other settings. The goal is that this would lead to decreased rates of failure or possibly allow athletes to return at an accelerated rate.

The ulnar collateral ligament (UCL) is composed of 3 bundles, the anterior oblique ligament (AOL), the posterior oblique ligament and the transverse ligament.<sup>1</sup> UCL injuries of the elbow commonly occur among overhead athletes and most notably in baseball pitchers. UCL injuries have increased in prevalence in recent years.<sup>2-4</sup> UCL reconstruction with a palmaris longus graft, commonly known as Tommy John surgery, has become the preferred treatment modality over ligamentous repair since first reported by Jobe et al. in 1986.<sup>5,6</sup> The goal of the reconstruction was to recreate the function of the AOL.<sup>1,7</sup> Since its introduction, the technique for UCL reconstruction has undergone various modifications, and the most commonly used are the docking technique and the modified Jobe technique.<sup>8</sup> Furthermore, there has been interest in techniques to augment primary UCL repairs with

suture material and anchors in the case of avulsion injuries.<sup>9-12</sup> In a recent study, Dugas et al. introduced a novel ulnar collateral ligament repair technique to restore valgus stability and allow faster return to play. The repair construct consists of direct repair of the ligament augmented by a spanning suture tape anchored at proximal and distal points of the native insertion of the anterior band of the UCL. Biomechanically, this construct has demonstrated a significantly greater resistance to gap formation during valgus loading when compared with conventional UCL reconstruction.<sup>6</sup>

We present an augmentation construct that incorporates a cross-linked suture tape into the palmaris longus tendon autograft for UCL reconstruction.

## Surgical Technique

This technique can be used with either a palmaris longus or gracilis tendon autograft or allograft. Other

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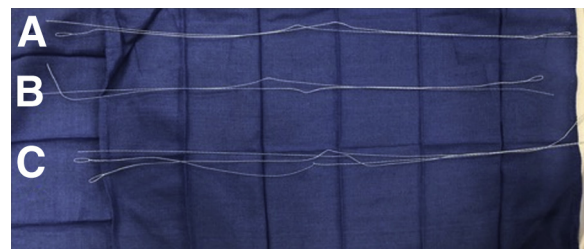
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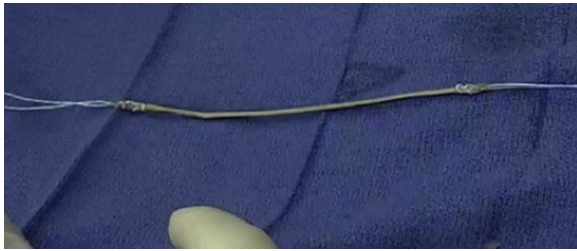
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**Fig 1.** FiberSnare suture (Arthrex) used for shuttle sutures. (A) Top 2 sutures for anterior humeral tunnel. (B) Middle 2 sutures for posterior humeral tunnel. (C) Bottom 3 sutures for ulnar tunnel.

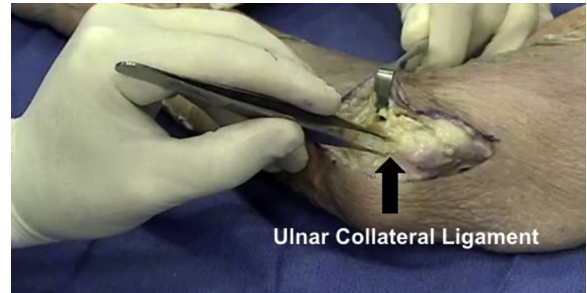


**Fig 2.** Palmaris longus graft with FiberLoop sutures. Palmaris longus tendon with no. 2 FiberLoop suture (Arthrex) on each end.

items that are used in this graft augmentation are 2 FiberLoop sutures (Arthrex, Naples, FL) with a straight needle and a FiberTape suture (Arthrex). We use 7 total suture shuttles. There are many options for the suture shuttles, but our current preference is the FiberSnare suture (Arthrex), a suture with a small loop on 1 end (Figs 1 and 2). From the UCL reconstruction tray, we use the Ulna V-Guide Drill, 55° (Arthrex; AR 7750-55), the intersecting V-Guide Obturator (Arthrex; AR 7751), adjustable humeral guide, 3.5- and 4.5-mm drill bits, a system 7 power drill, and curved curette. The UCL Suture Passing Disposable Kit includes: no. 2 TigerLoop, no. 2 FiberLoop, Curved Micro SutureLasso with wire loop, 4.5-mm wire skid, Chamfer tool, 2 suture passing



**Fig 3.** Instrument tray setup from ulnar collateral ligament reconstruction tray (Arthrex). Instruments listed left to right, top to bottom: UCL graft sizing block, UCL humeral tunnel drill bit 3.5 or 4.5 mm, UCL humeral socket drill guide 3.5 or 4.5 mm, adjustable humeral guide 3.5 or 4.5 mm, blunt free needle, intersecting V-Guide Obturator, 2 no. 2 Tigerloops, Orange microsuture lasso and suture lasso blue sled, drill chuck, Ulna V—drill guide (55°), marking pen, Baby Hohmann, small Kocher, small Metzenbaum scissors, small Weitlaner retractor, small Gelpi retractor, 2 Kelly clamps, Mayo Hagar needle holder, key elevator, Freer elevator, ruler, no. 3 knife handle, and 15 blade loaded. System 7 power drill (not pictured). Products from Arthrex. UCL, ulnar collateral ligament.



**Fig 4.** Medial elbow dissection: right elbow. Careful dissection of the medial aspect of the elbow enables the surgeon to identify the UCL (black arrow). This medial elbow dissection is being performed on a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left. UCL, ulnar collateral ligament.

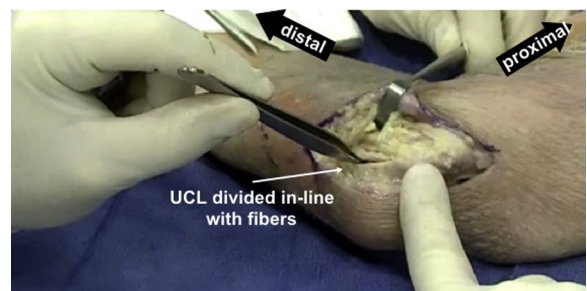
wires, SuturePasser, blunt curved needle with Nitinol Loop, and 6-inch ruler (Arthrex; 7,715-4.5) (Fig 3). The surgeon or assistant will also want to have available the following: needle driver, suture scissors, and closed tendon stripper.

#### Patient Position

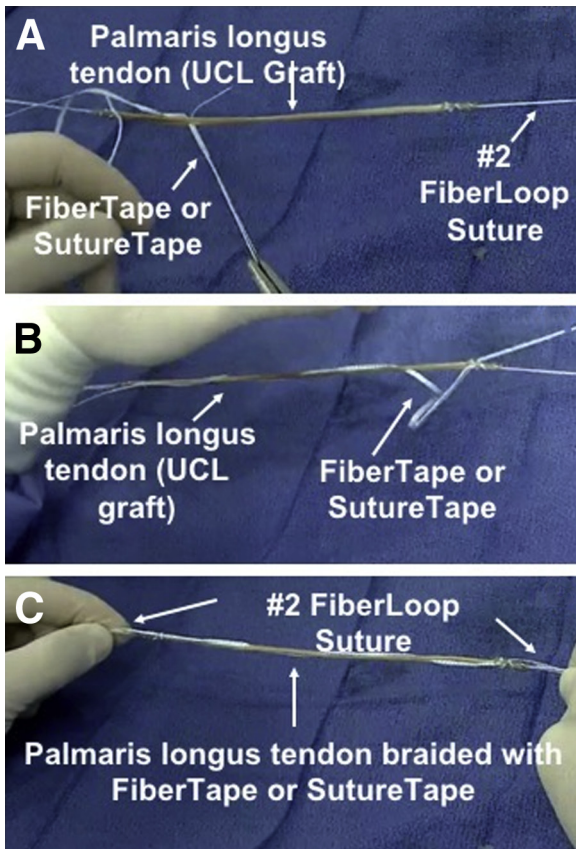
The patient is positioned supine on the operative table. A hand table is attached to the bed on the patient's operative side. If harvesting the gracilis, we use the tendon from the contralateral leg, so this leg is prepped and draped. A tourniquet is placed on the upper arm on the operative side and inflated to 200 mm Hg. The arm is prepped and draped in sterile fashion.

#### Incision and Approach

The modified Jobe technique (our preferred technique) has been previously described,<sup>13</sup> as has the use of the Arthrex drill guides. We will go through the steps briefly only to add a few slight modifications that have not been previously described. A longitudinal incision is made on the medial aspect of the elbow, angled at the medial condyle, approximately 8 to 10 cm in length

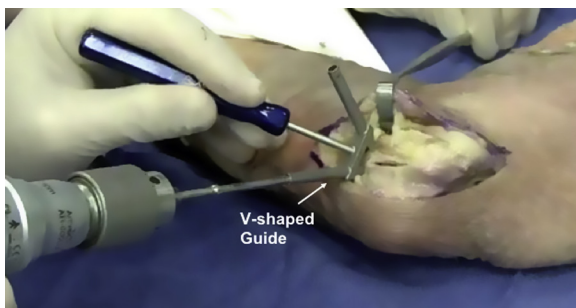


**Fig 5.** Splitting the UCL. The UCL is divided in-line with its fibers, and the articular surface of the ulnohumeral joint is identified. This is being performed on the medial side of the right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left. UCL, ulnar collateral ligament.



**Fig 6.** Weaving the FiberTape or SutureTape into the Palmaris longus tendon graft. (A, B) The FiberTape or SutureTape suture is weaved into palmaris longus tendon graft. (C) The appearance of the final graft preparation where the graft and suture are braided together. UCL, ulnar collateral ligament.

(Fig 4). The incision is posterior to the medial epicondyle. Care is taken to protect the medial antebrachial cutaneous nerve. The ulnar nerve is released and typically an anterior subcutaneous transposition is



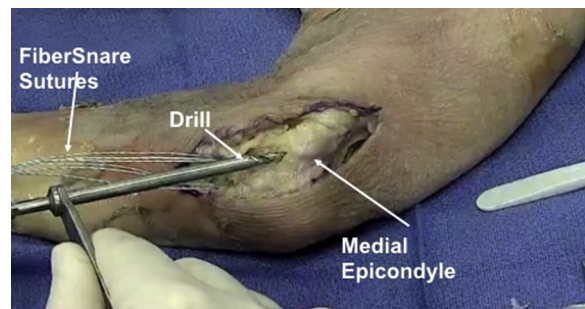
**Fig 7.** Drilling the ulnar tunnel. The 55° V-shaped guide is used to drill the tunnel on the ulna. The tunnel is placed 5 to 7 mm distal to the ulnohumeral articular surface and is centered over the sublime tubercle. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

**Table 1.** Pearls and Pitfalls to Preparing Bone Tunnels and Graft Passage

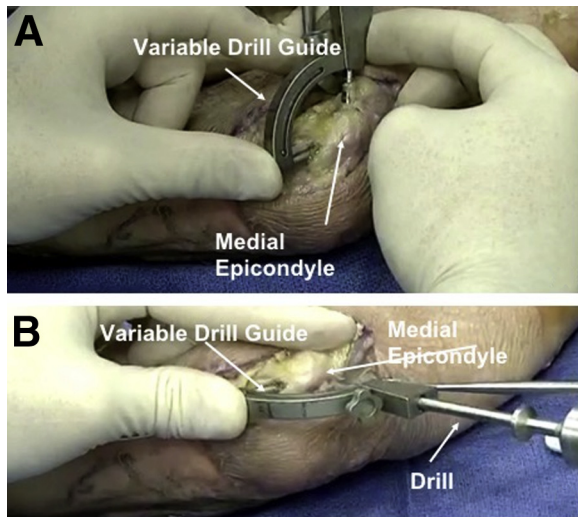
Step	Pearl	Pitfall
Angle of drill on medial epicondyle	Drill at proximal attachment of UCL, approximately 20-30° coronal and 10° posterior	If not aimed posterior, you will skive anteriorly
Shuttle suture	Prepass 4 shuttle sutures on the medial epicondyle	Once graft is in the tunnel, it becomes difficult to pass shuttle suture
FiberSnare suture or looped suture as a shuttle for graft passage	Makes for smoother graft passage	Making a knotted loop out of suture can catch or become difficult to pass
Passing fiber loop suture on ends of graft	Passes should be close to each other to keep the end narrow for easy passes	End of graft can bunch and become difficult to pass
Tension during graft passage	Maintain tension on both sides of graft as you make the pass through the tunnels	Pulling only on 1 end can cause the graft to bunch within the tunnel

UCL, ulnar collateral ligament.

performed as part of the case. Muscular branches of the ulnar nerve are preserved. A vessel loop is used to allow for gentle retraction of the ulnar nerve throughout the case. The flexor carpi ulnaris is elevated to expose the ulnar collateral lateral ligament. The AOL, which originates on the anterior inferior aspect of the medial epicondyle (46 mm<sup>2</sup> footprint) and inserts approximately 5 mm distal to the ulnohumeral joint onto the sublime tubercle (128 mm<sup>2</sup> footprint),<sup>11</sup> is exposed carefully. The ligament is divided in line with its fibers



**Fig 8.** Drilling the humeral tunnel. The humeral tunnel is drilled by placing the drill bit at the origin of the UCL on the medial epicondyle. Note that care should be taken not to place the tunnel too medial or too anterior. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left. UCL, ulnar collateral ligament.

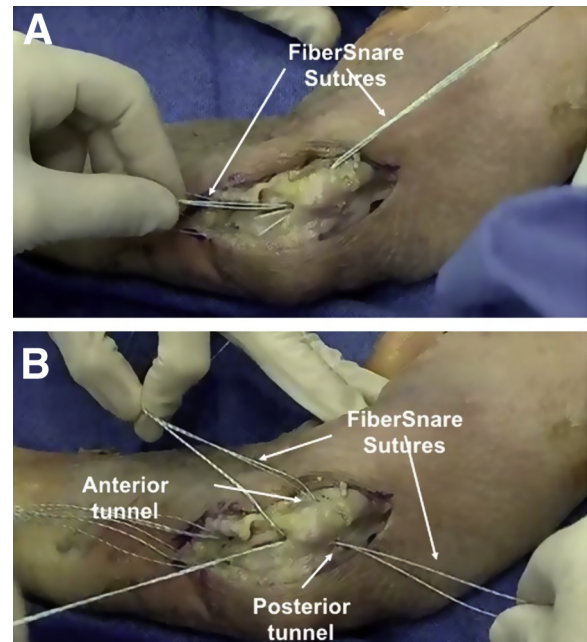


**Fig 9.** Completing the Y-shaped tunnels. (A, B) The variable drill guide (Arthrex) is used to drill anterior and posterior on the proximal part of the medial epicondyle. This completes the Y-shaped tunnels. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

to expose the articular surface of the ulnohumeral joint (Fig 5).

### Graft Harvest and Preparation

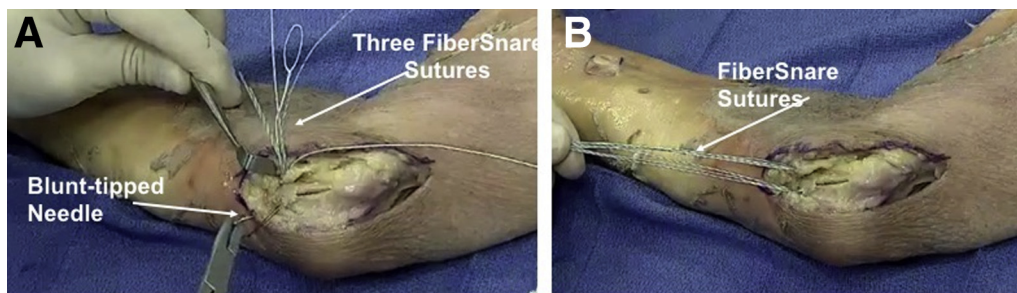
The surgeon may choose to harvest the palmaris longus or gracilis. Harvest of both the palmaris longus and the gracilis tendons have also been previously described. The ipsilateral palmaris longus autograft is harvested in standard fashion as described by Kaplan et al.<sup>13</sup> Gracilis tendon autograft may also be used if the palmaris longus is not present. This is harvested as described by Dugas et al.<sup>14</sup> Once the graft is harvested, 2 FiberLoop sutures are incorporated into the graft, 1 on either side in whipstitch fashion (Fig 6). A collagen coated FiberTape suture is then used to augment the graft by weaving the FiberTape through the graft (Video 1). The graft is now ready to be implanted.



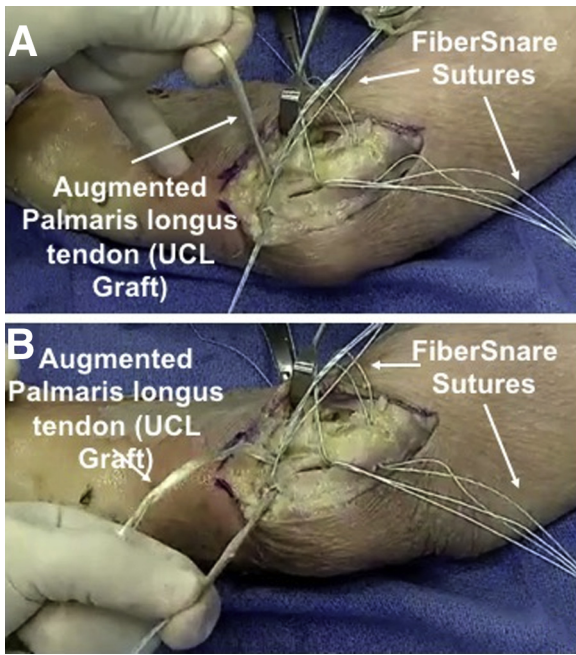
**Fig 11.** Passing the FiberSnare sutures into the anterior and posterior humeral tunnels. (A) Two FiberSnare sutures (Arthrex) are passed into the anterior tunnel and 2 are passed into the posterior tunnel. The looped ends are placed in opposite directions. Passing the FiberSnare sutures is easier when it is done before passing the palmaris longus tendon graft into the tunnels. (B) The final appearance once the FiberSnare sutures are passed through the anterior and posterior tunnels. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

### Tunnel Drilling

**Ulnar Tunnel.** The 2 ulnar tunnels are drilled and connected, anterior and posterior to the sublime tubercle, using the 55° V-shaped guide (Arthrex) or drilled by freehand (Fig 7). A 3.5- or 4-mm drill is used. Alternatively, a 9/64 drill can be used for palmaris longus graft or a 5/32 drill can be used for a gracilis



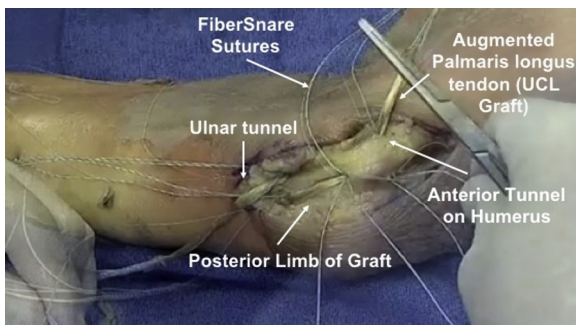
**Fig 10.** Passing the FiberSnare sutures into the ulnar tunnel. (A) A blunt-tipped needle (Arthrex) is used to pass 3 FiberSnare sutures, which will be used as shuttles. Passing all 3 FiberSnare sutures now is easier than trying to pass the additional FiberSnare sutures after the palmaris longus tendon graft has been passed through. (B) The final appearance after all 3 FiberSnare sutures have been passed. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.



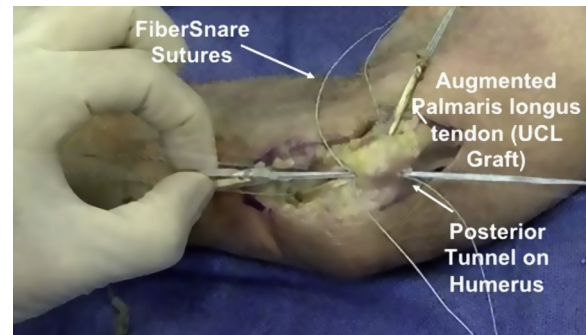
**Fig 12.** Passing the graft into the ulnar tunnel. (A) The palmaris longus tendon graft, previously braided with FiberTape or SutureTape, is passed into the ulnar tunnel. Tension is maintained on the back-side of the graft to allow for easier passage through the tunnel. (B) The final appearance after the graft is passed through the ulnar tunnel. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

graft. Care is taken to ensure the bone tunnel is distal to the joint with a 1- to 1.5-cm bone bridge between the tunnels (Table 1). Curettes are then used to remove remaining bone debris.

**Humeral Tunnel.** The humeral sided tunnels are drilled at the medial epicondyle in typical Y-shaped pattern



**Fig 13.** Passing the graft from the posterior ulnar tunnel into the anterior humeral tunnel. The posterior limb of the augmented palmaris longus tendon graft located in the ulnar tunnel is passed into the anterior tunnel on the humerus. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

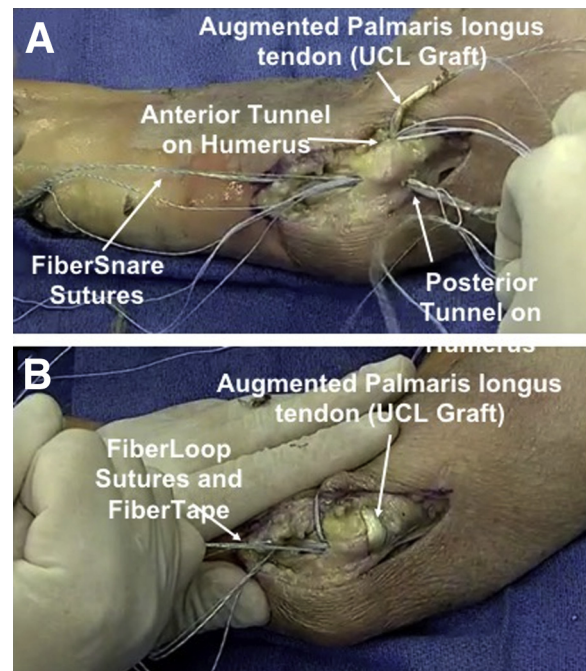


**Fig 14.** Passing the graft from the anterior ulnar tunnel into the posterior humeral tunnel. The anterior limb of augmented palmaris longus tendon graft in the ulnar tunnel is passed into the posterior tunnel on the humerus. Tension is maintained on the back side of the graft to allow for easier passage through the tunnel. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

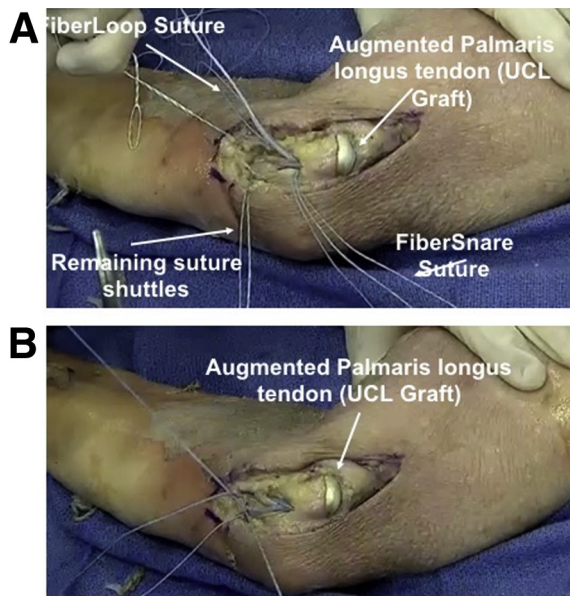
with the single limb distal and upper limb portions proximally (Figs 8 and 9). Curettes are then used to remove remaining bone debris before graft passage.<sup>14</sup>

**Graft Passage**

The graft is then passed in a figure-of-8 fashion as previously described (Figs 10 and 11-16).<sup>13</sup> It is

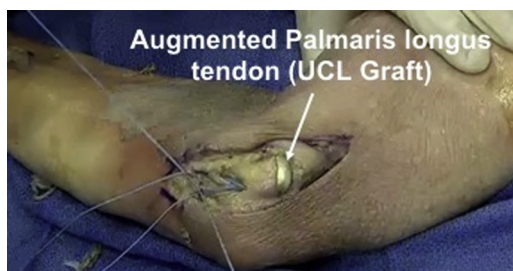


**Fig 15.** Completing the figure-of-8 UCL reconstruction. (A) The FiberSnare sutures in the anterior tunnel are passed into the posterior tunnel and vice versa. (B) Any slack is then taken out of the graft limbs. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.

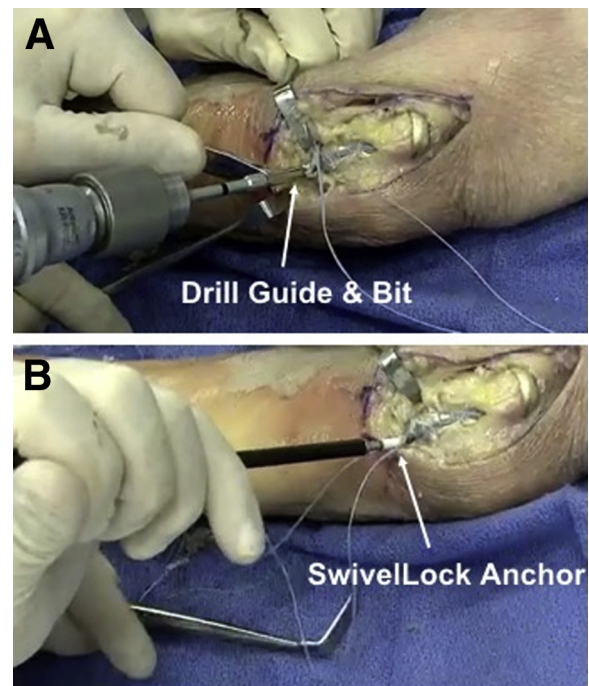


**Fig 16.** Completing the figure-of-8 UCL reconstruction. (A) There are 2 remaining suture shuttles in the ulnar tunnel. These sutures are used to pass the FiberLoop suture limbs and the FiberTape 1 additional time to complete the figure-of-8 ligament reconstruction. (B) Appearance of the medial elbow after the completion of the figure-of-8 ligament reconstruction. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left. UCL, ulnar collateral ligament.

important to keep countertension on the graft as you pull the graft through each bone tunnel (Table 1). The FiberLoop sutures and the FiberTape sutures (Arthrex) are passed back through the ulnar tunnel and are tied over the bone bridge completing an implant-less internal brace (Fig 17). The graft is tensioned in neutral rotation with flexion of the elbow. It has been noted that grafts tensioned at 45 to 70° of flexion had a lower



**Fig 17.** Securing of the graft limbs—method 1. (A) Appearance of the medial elbow after the completion of the figure-of-8 ligament reconstruction. After the final suture pass, the limbs are secured by tying them over the bone bridge. This creates an internal brace, with or without an implant. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.



**Fig 18.** Securing of the graft limbs—method 2. (A, B) Appearance of the medial elbow after the completion of the figure-of-8 ligament reconstruction. After the final suture pass, the limbs are secured to the Ulna using a 3.5-mm SwivelLock anchor. This creates an internal brace, with or without an implant. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left.



**Fig 19.** Bundling the ends of the graft. (A) No. 0 Vicryl suture is used to bundle the 2 limbs of the graft together. (B) Final presentation upon completion of UCL reconstruction with tape augmentation of palmaris longus tendon autograft. This is being performed on the medial side of a right elbow cadaveric specimen in a supine position such that the hand (distal) is on the left. UCL, ulnar collateral ligament.

**Table 2.** Advantages and Disadvantages of Suture Augmented Graft for UCL Reconstruction

Advantages	<ul style="list-style-type: none"> <li>• Potentially Stronger Construct that May Improve Return to Play Percentage and Improve Return Time to Sport.</li> <li>• Potentially Decreases Elongation of the Graft during the Early Postoperative Period, which has Been Demonstrated in Previous Studies.</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>• The surgeon will have to learn additional steps to the technique.</li> <li>• The internal brace may damage the integrity of the graft with multiple passes.</li> <li>• There is an increased risk of infection because of implantation of the internal brace.</li> <li>• Reinforcing the graft may add surgical time to the procedure when first beginning.</li> <li>• Additional cost of the suture, equipment, and internal brace to the procedure.</li> </ul>

UCL, ulnar collateral ligament.

rate of revision.<sup>1</sup> An optional SwiveLock knotless anchor can be used to secure distal strands of FiberTape for additional fixation (Arthrex) (Fig 18). 0-Vicryl suture is used to bundle the 2 limbs of the graft together and remaining suture limbs are cut (Fig 19). Anterior ulnar nerve transposition is performed subcutaneously with a flexor-pronator and/or intermuscular septum fascial sling. The wound is then irrigated, and subcutaneous and skin layers are closed.

### Postoperative Care

Sterile dressings are applied, and the patient is placed in a hinged elbow brace locked in a little less than 90° of flexion. Our rehabilitation protocol begins the next day with an early emphasis on wrist and hand motion. Elbow motion is limited for the first week to allow healing of the ligament reconstruction and subcutaneous ulnar nerve transposition. The modified Jobe technique allows for early and aggressive range of motion of the wrist and forearm because it is a muscle-splitting approach with no disruption of the flexor-pronator origin, which allows for active range of motion of the wrist and hand. After the first week, the hinged elbow brace will allow for 30° to 100° of elbow motion, which is increased by 5° each week until full passive motion is regained by approximately week 5 or 6.<sup>15</sup> The patient will then progress through criteria-based phases of rehabilitation. Return to activities are based on time for the graft to incorporate into the tunnels, ligamentization of the graft, satisfactory subjective test scores, and physical examination. Finally, the patient must demonstrate return of strength before it is determined that he or she is safe for return to higher level activities, including a closely monitored interval throwing program. This is followed by a reintegration to sport with a progressive increase in activity and workload.

### Discussion

The suture tape augmented UCL reconstruction presented in this technique article was developed as a way to improve the mechanical load to failure of our graft and potentially decrease the percentage of failures. There is concern regarding over constraint creating a

stress-shielding effect. However, Noonan et al.<sup>12</sup> recently demonstrated that suture tape augmentation of grafts for anterior cruciate ligament reconstruction leads to higher ultimate load to failure without stress-shielding the soft-tissue graft. Further study will demonstrate if there is any stress shielding in this specific setting.

Another concern is that there is a possibility that the suture tape may not be biocompatible when weaved into the palmaris longus tendon graft and implanted about the elbow. However, Smith et al.<sup>16</sup> assessed intra-articular biocompatibility of suture tape when implanted adjacent to the native anterior cruciate ligament in a canine model and found that there were no local inflammatory reactions, cartilage erosions, or premature osteoarthritis. Suture tape augmentation has been used in other extra-articular applications without any apparent complications related to the materials.<sup>9,10</sup>

The goal is to develop a technique to improve UCL surgery by increasing the rate of return to sport and reduce the chance of a repeat injury. An additional goal is to decrease the time to return, if this were possible. Table 2 outlines the advantages and disadvantages of this suture augmented graft technique for UCL reconstruction. Further studies will be needed to see if this graft preparation can be of benefit in any of these categories.

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