Technical Note

Inverted Mattress Knotless Repair of Medial Ulnar Collateral Ligament Avulsion Injury Using Flat Braided Suture Internal Brace

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Abstract: Direct repair of ulnar collateral ligament (UCL) injuries with suture augmentation has been successful in properly selected patients lacking chronic attritional wear of the medial elbow. Described is a Speed-Fix technique for direct UCL repair using SutureTape, with *Internal*Brace augmentation. The Speed-Fix repair technique uses an inverted mattress knotless repair with a knotless SwiveLock anchor and FiberTape suture, which allows for theoretical compression at the repair site. However, the proposed technique uses a 0.9-mm SutureTape to decrease tissue pullout and an *Internal*Brace to provide time-zero repair stability. For patients with ulnar nerve pathology, a pronator mass elevation was used for exposure, whereas a muscle-splitting approach was used for those without ulnar nerve pathology. With this technique, all patients were able to return to sport and were able to do so at an accelerated rate without repair failures.

Direct ulnar collateral ligament (UCL) repair has been shown to provide successful outcomes when used in young athletes with proximal or distal avulsion injuries.[1-4] As young athletes lack the chronic attritional damage found throughout the elbows of professional pitchers, these patients may be more amenable to direct repair.[4-11] Recent success of direct UCL repair may be attributable to improved patient selection, as well as the release of the *Internal*Brace (Arthrex, Naples, FL). The *Internal*Brace is a collagen-coated fiber tape that provides an additional measure of protection during the initial healing phase of the repaired ligament.[12] In young athletes, direct UCL repair with suture augmentation has been reported to have high return to sport (92%-97%) and expedited return to sport (6 months postoperatively).[4,12,13]

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With renewed interest in direct repair, various repair techniques using suture augmentation have been described.[14-18] We present an alternative construct using a Speed-Fix repair technique with SutureTape (Arthrex), augmented with an *Internal*Brace. The Speed-Fix repair technique uses an inverted mattress knotless repair using 0.9-mm SutureTape. We hypothesized that this technique would provide theoretical advantages in repair site compression and tissue pull-through. The institutional review board of Northwell Health provided approval (23-0166).

Surgical Technique

The distinguishing characteristics of this technique are summarized in Table 1, and the technique is demonstrated in Video 1.

Patient Positioning

The patient is positioned supine and sequential compression devices are applied. A tourniquet is applied to maximize visualization during exposure. An examination under anesthesia is performed to determine the degree of instability with valgus stress. After the patient is draped in typical sterile fashion, time-out is performed.

UCL Exposure

Before incisions are made, antibiotic prophylaxis with 2 g of Kefzol (unless contraindicated) is

Table 1. Ulnar Collateral Repair Technique

Steps	Pearls
Positioning	Supine
	No regional block for postoperative ulnar nerve evaluation
	Keep tourniquet high
Incision	If ulnar nerve transposition: 6-8 cm over medial epicondyle
	If muscle-splitting approach: 5 cm distal to medial epicondyle
Approach	Pronator mass elevation if ulnar nerve transposition (if symptomatic)
	Muscle splitting approach if no ulnar nerve transposition
Repair	Initial repair is at avulsed attachment site (proximal or distal)
	Inverted mattress stitch with 0.9 SutureTape
	0.9-mm SutureTape passed through SwiveLock that is preloaded with FiberTape
	Arm flexed to 30° with slight varus during anchor placement
	0.9-mm SutureTape suture used to close intra-articular portion
*Internal*Brace	*Internal*Brace set at side of injury with anchor placement
	FiberTape brought through SwiveLock at opposite attachment site
Ulnar nerve transposition	Performed if ulnar nerve symptoms preoperatively (neuritis or instability)
	Pronator mass elevation approach
	Ulnar nerve transposed anteriorly beneath loose intermuscular septal sling attached to the flexor pronator mass
Closure	Flexor pronator split or muscle split closed with 0 VICRYL
	Close cubital tunnel
	Skin closed with 2-0 VICRYL and 3-0 running MONOCRYL

NOTE. Important technical steps are described throughout the table, with distinctions provided between the flexor pronator mass and muscle-splitting approaches.

administered. Esmarch is applied and the tourniquet is inflated to 250 mm Hg. A 6- to 8-cm linear incision is made centered over the medial epicondyle (Fig 1). A combination of sharp and blunt dissection is performed through the skin and subcutaneous tissues, with flaps raised anteriorly and posteriorly. The median antebrachial cutaneous nerve is identified and protected with a vessel loop. For those patients with preoperative ulnar nerve pathology, the flexor pronator mass (FPM) is elevated, and ulnar nerve transposition (UNT) is performed. For those patients without ulnar nerve pathology, a muscle-splitting approach is used, allowing for a smaller incision (Fig 2). With FPM elevation and UNT, the ulnar nerve is identified and protected with a vessel loop before the cubital tunnel is released proximally from the triceps and distally to the FPM. The medial intermuscular septum is released from proximal to distal, maintaining its distal attachment

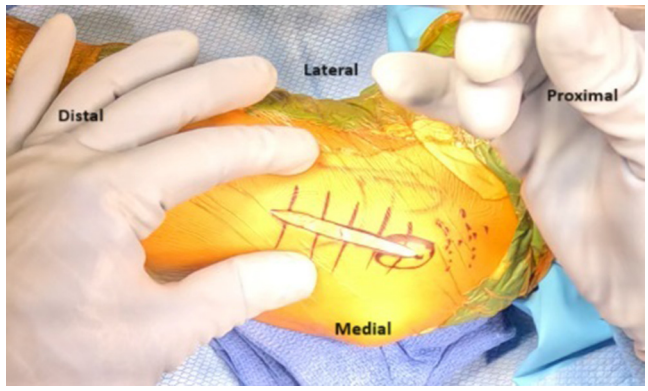

Fig 1. The surgeon is positioned at the bottom of the image and located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. After sterile draping, incision is made centered 5 cm distal to the medial epicondyle. (UCL, ulnar collateral ligament.)

to the medial epicondyle for later use as a fascial sling for the UNT. The FPM is raised from posterior to anterior with careful retractor placement to protect the ulnar nerve. The UCL is then identified and split in line with its fibers, revealing the proximal or distal UCL tear (Fig 3).

Ligament Repair and Augmentation

Ligament repair is performed, beginning at the site of avulsion injury. The proximal or distal footprint of the injured UCL is debrided down to bleeding bone (Fig 4). For proximal avulsion injuries, drill and taps are passed at the medial epicondyle, aimed up the medial column to avoid intra-articular injury. For

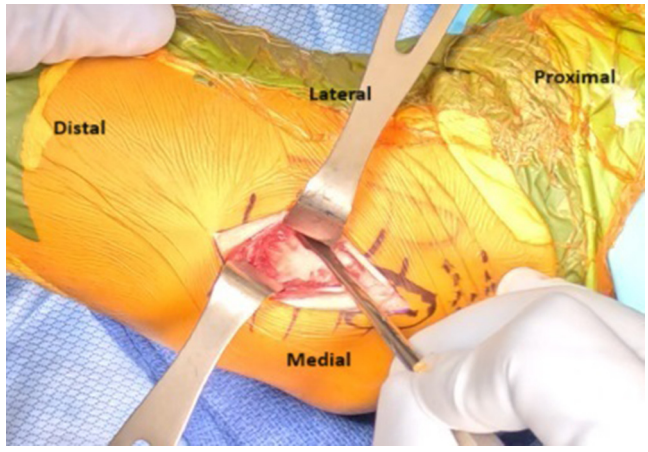

Fig 2. The surgeon is positioned at the bottom of the image and located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. The surgeon uses a muscle-splitting approach to expose the UCL. However, in the presence of ulnar nerve symptoms, the surgeon would have used a flexor pronator mass elevation approach for visualization and transposition of the ulnar nerve. (UCL, ulnar collateral ligament.)

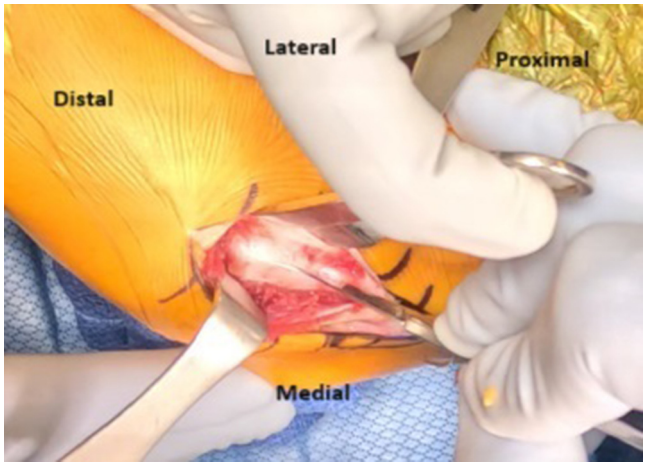

Fig 3. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. The superficial UCL is split in line with its fibers to reveal the underlying distal tear. (UCL, ulnar collateral ligament.)

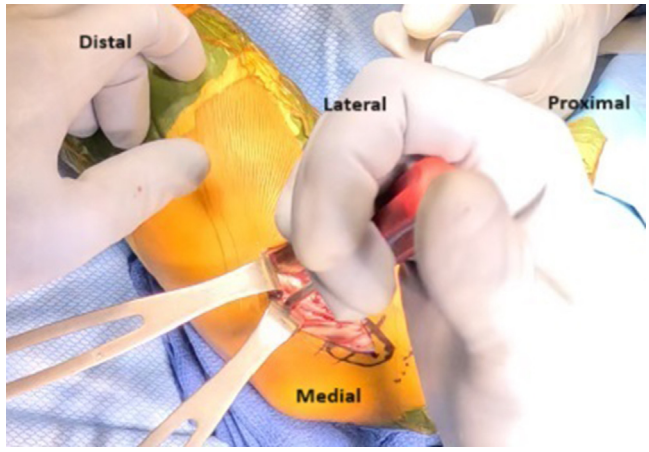

Fig 5. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. After adequate preparation of the distal footprint, drill and taps from the *Internal*Brace kit are used to prepare the socket at the isometric point of the sublime tubercle in anticipation of distal anchor placement. (UCL, ulnar collateral ligament.)

distal avulsion injuries, drill and taps are passed at the sublime tubercle (Fig 5). An inverted horizontal mattress stitch is passed using 0.9-mm SutureTape in the avulsed end of the ligament (Fig 6). The SutureTape is then passed through the 3.5-mm PEEK (polyether ether ketone) SwiveLock (Arthrex) suture anchor, which is preloaded with collagen-coated FiberTape (Arthrex) suture (Fig 7). With the arm positioned at 30° of flexion and slight varus, the SwiveLock anchor is placed into the medial epicondyle or sublime tubercle, for proximal or distal avulsions respectively, repairing the ligament and setting the *Internal*Brace (Fig 8). The SutureTape sutures are then back-passed through the ligament and tied (Fig 9). The ligament is closed with interrupted SutureTape sutures to close the intra-articular portion of the UCL (Fig 10). Drill and taps are then passed for the SwiveLock suture anchor at the uninjured side of the ligament, which is used to secure the *Internal*Brace and complete the repair with the elbow positioned at 30° of flexion and slight varus (Figs 11 and 12).

For cases in which the FPM is elevated, the ulnar nerve is transposed anteriorly beneath the loose intermuscular septal sling attached to the FPM. The distal flexor pronator split is closed with No. 0 VICRYL (Ethicon Inc, Raritan, NJ) suture to avoid muscle herniation. The cubital tunnel is closed with

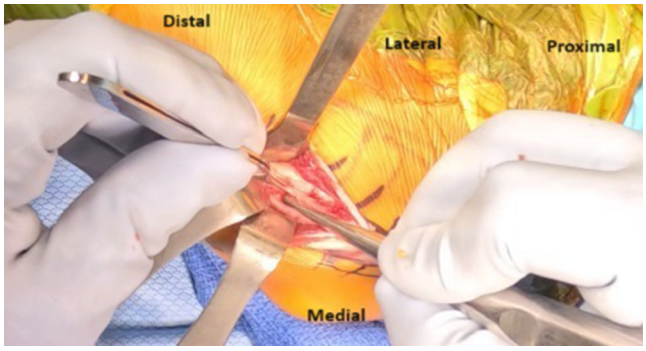

Fig 4. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. After the UCL tear is identified, the distal footprint at the sublime tubercle of the ulnar is prepared by debriding down to bleeding bone. (UCL, ulnar collateral ligament.)

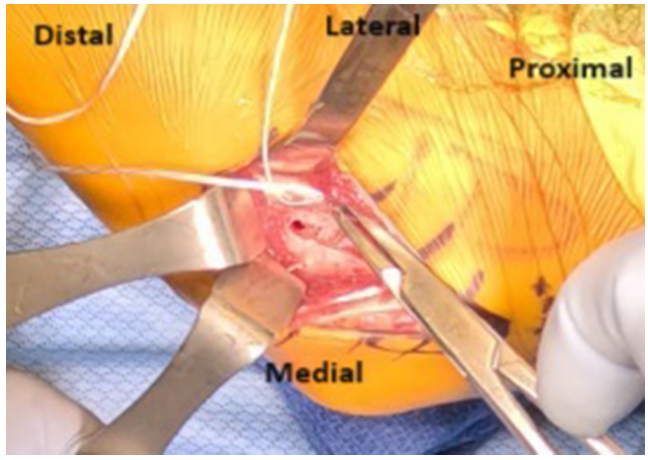

Fig 6. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. A 0.9-mm SutureTape is passed in an inverted mattress fashion in the distal aspect of the avulsed UCL. Suture tails are kept deep to the UCL and are later used as the SpeedFix repair suture. (UCL, ulnar collateral ligament.)

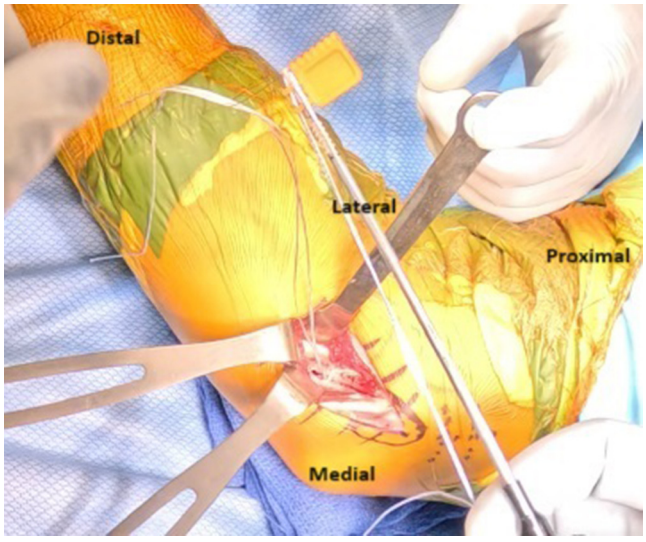

Fig 7. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. The 0.9-mm SutureTape that was passed through the UCL is loaded onto a 3.5-mm SwiveLock suture anchor that is preloaded with collagen-coated FiberTape. (UCL, ulnar collateral ligament.)

a 0 VICRYL suture. For the muscle-splitting technique, the flexor pronator fascia is closed using a 0 VICRYL baseball stitch. Thorough irrigation is performed and the tourniquet is deflated. The skin is closed with No. 2-0 VICRYL suture beneath a running 3-0 MONOCRYL (Ethicon Inc) suture. Steri-Strips (3M, St. Paul, MN) and sterile surgical dressings are applied. The arm is placed in a posterior slab splint positioned at 90° until the first postoperative evaluation. This splint is removed at

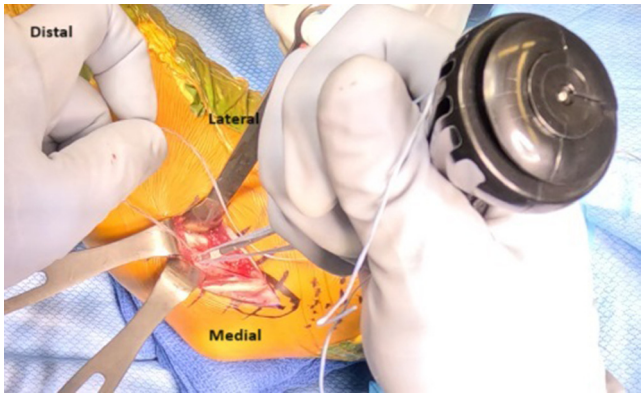

Fig 8. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. After proper tensioning, the SwiveLock anchor is seeded and inserted into the previously drilled distal anchor site, completing the SpeedFix repair of the avulsed distal UCL. (UCL, ulnar collateral ligament.)

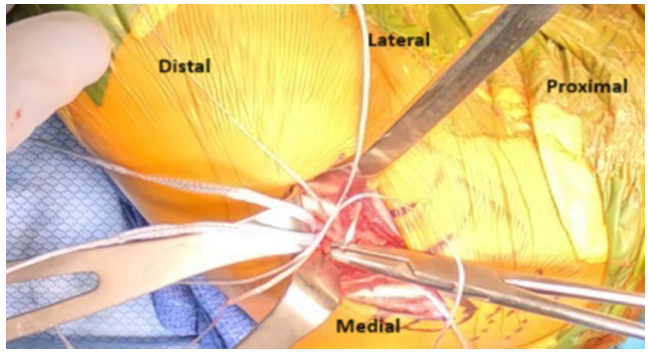

Fig 9. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. The excess strands of the 0.9-mm SutureTape are then back-passed and tied down, further closing the distal UCL over the sublime tubercle footprint. (UCL, ulnar collateral ligament.)

physical therapy, which is initiated 24 to 48 hours postoperatively.

Two weeks postoperatively, patients are followed up for a wound check and are transitioned from the posterior slab splint to an elbow brace locked at 20° to 90° of flexion, avoiding terminal ranges of motion. Range of motion is progressed 10° weekly until full motion is achieved.

Discussion

In the proposed surgical technique, a Speed-Fix repair of the UCL is performed using SutureTape and augmented with an *Internal*Brace. The Speed-Fix technique uses an inverted mattress knotless repair technique. This technique has been used for both proximal

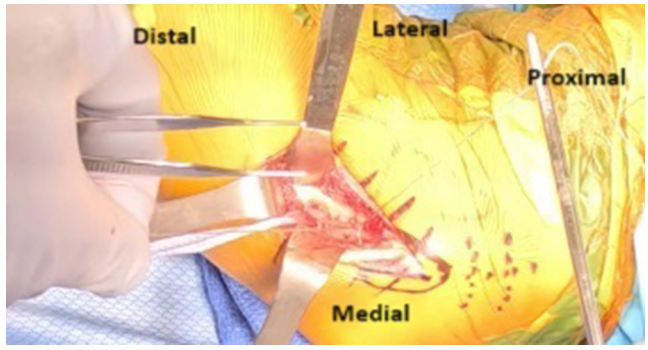

Fig 10. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. The central aspect of the UCL is then repaired with 0.9-mm SutureTape in interrupted figure-of-eight fashion as warranted on the basis of the length of the patient's UCL. (UCL, ulnar collateral ligament.)

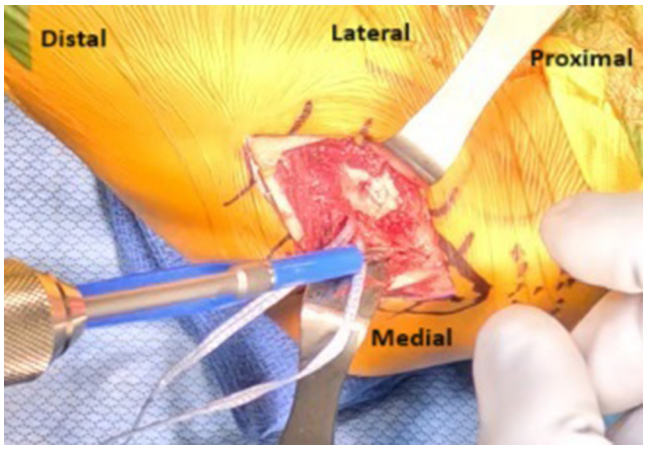

Fig 11. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. Drill and taps are passed at the isometric point of the proximal UCL at the medial epicondyle. Care is taken to drill up the medial column to prevent intra-articular injury. (UCL, ulnar collateral ligament.)

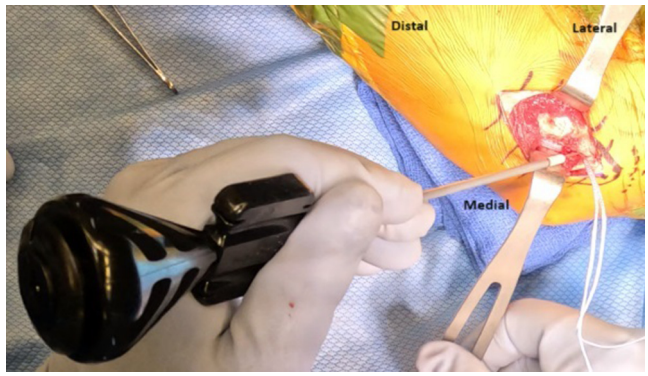

Fig 12. The surgeon is positioned at the bottom of the image and is located on the medial aspect of the right elbow during repair of a distal UCL avulsion injury. The FiberTape from the initial repair is passed and loaded onto a 3.5-mm SwiveLock anchor. After proper tensioning with the elbow positioned in 30° of flexion and slight varus, the SwiveLock anchor is placed in the socket that was previously drilled and tapped at the isometric position on the medial epicondyle, thus securing the *Internal*Brace. (UCL, ulnar collateral ligament.)

and distal attachment injuries, with repair beginning at the side of the avulsion. In the experience of the senior author, distal injuries are more commonly repaired because of their poor blood supply, limiting their healing potential. Although direct repair with suture augmentation has been previously described, the use of a Speed-Fix repair technique with 0.9-mm SutureTape has not been reported.

Dugas et al.[12] successfully used direct suture repair augmented with the *Internal*Brace. In this technique, repair was performed using 0-FiberWire (Arthrex), preloaded into a 3.5-mm knotless SwiveLock suture anchor. The anchor was secured at the attachment site of injury, and then an inverted mattress stitch was thrown through the injured ligament. The suture was back-passed and tied down to the anchor. In contrast, the Speed-Fix repair technique requires the repair suture to be passed through the UCL and then preloaded through the SwiveLock anchor before placement of the anchor. This allows the repaired ligament to be "dunked" into the repair site, adding theoretical compression at the ligament-bone interface. In addition, the use of SutureTape allows for increased resistance to tissue pull-through.

The proposed Speed-Fix technique with SutureTape and *Internal*Brace augmentation offers theoretical benefits, including compression at the ligament-bone interface, increased resistance to tissue pull-through, and time-zero stability (Table 2). Surgeons must demonstrate excellent surgical technique to avoid the risk of complications (Table 3). Future randomized control trials are required to evaluate the success of the Speed-Fix technique in comparison with alternative UCL repair techniques.

Table 2. Advantage and Disadvantages

Advantages	Disadvantages
Faster operative time with SpeedFix repair	Increased cost with *Internal*Brace
Eliminates need for graft harvest	Relies on isometric anchor placement and suture tensioning
Preservation of native anatomy	Risk of overconstraining the elbow
Muscle-split approach decreases morbidity in the absence of ulnar nerve pathology	Chronic tears with degenerative changes may not be amenable
SutureTape with decrease tissue pullout	Long-term outcomes are required to determine efficacy
Internal brace with time-zero stability	
Expedited return to sport	

NOTE. The proposed technique offers advantages and disadvantages compared with ulnar collateral ligament reconstruction and other repair techniques.

Table 3. Pearls and Pitfalls

Pearls	Pitfalls
Proper patient selection is key	Poor integrity tissue/chronic degenerative changes at risk of poor outcome
Flexor pronator mass elevation only if ulnar nerve pathology to decrease morbidity	Risk of fracture without tapping before anchor placement
Decorticate anchor site to bleeding bone for healing	Proud anchors with risk of pullout/failure
Proximal drill/taps aimed up medial column to avoid intra-articular injury	Failure to close distal flexor pronator split may cause muscular herniation
Tension sutures at 30° of flexion and slight varus	Improper anchor placement and suture tensioning can lead to overconstraint
If ulnar nerve released, use of loose intermuscular septal sling attached to flexor pronator mass for transposition	

NOTE. Although many of the risks of ulnar nerve reconstruction are avoided with direct repair techniques, exceptional surgical technique is required to restore anatomy and avoid complications.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: J.M.P. reports consulting or advisory, equity or stocks, and speaking and lecture fees from Arthrex; consulting or advisory from DJO; and equity or stocks from Firefly, OrthoCor, and Core Sports Motus Global. All other authors (B.K., L.E.B., C.B.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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