Technical Note

Distal Triceps Speed Bridge Repair

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Abstract: Distal triceps ruptures are uncommon injuries resulting in loss of elbow extension strength and necessitating surgical repair to ensure optimal functional outcome. Traditional fixation techniques using running, locking sutures through the tendon secured through bone tunnels have been shown to poorly restore the anatomic footprint and are mechanically inferior to anatomic repairs. We endorse restoring the anatomic footprint of the distal triceps, similar to the well-researched rotator cuff repair model.

Distal triceps injuries often result from a fall on an outstretched arm or a forced eccentric contraction and can result in significant dysfunction. Triceps tendon ruptures have been associated with prior local steroid injections, anabolic steroid use, olecranon bursitis, and hyperparathyroidism. Weight lifters, professional football players, and males are at a higher risk of triceps injuries. Although case reports of myotendinous injuries are documented, the vast majority of triceps ruptures occur at the distal insertion onto the olecranon. Surgical fixation is essential to restore normal extension power of the elbow.[1]

Traditionally, distal triceps ruptures were repaired using nonabsorbable sutures passed through the tendon in a running, locking fashion. The sutures were then shuttled through bone tunnels in the olecranon and tied together over a bony bridge. The evolution of distal triceps repair techniques has mirrored that of rotator cuff repair. More novel techniques have been described using suture anchors alone or in combination with bone tunnels in an effort to reestablish the anatomic footprint and strength of repair.[2,3] Research regarding the distal triceps is sparse when compared with other common tendon insertions (rotator cuff, Achilles, etc.), but Yeh et al.[3] described the olecranon footprint as having an area of 466 mm^2. They also reported that more traditional repair techniques fail to recreate the footprint compared with more recent anatomic repairs. We present our distal triceps speed bridge repair technique using suture anchors and high-strength sutures in an effort to restore the anatomic footprint and potentially improve fixation strength and allow a more rapid rehabilitation.

Surgical Technique

Our technique uses the traditional supine position with a well-padded pillow across the chest but is certainly amendable to a lateral decubitus positioning as well (Video 1). In our experience, the supine position permits an easier setup but often requires an assistant to

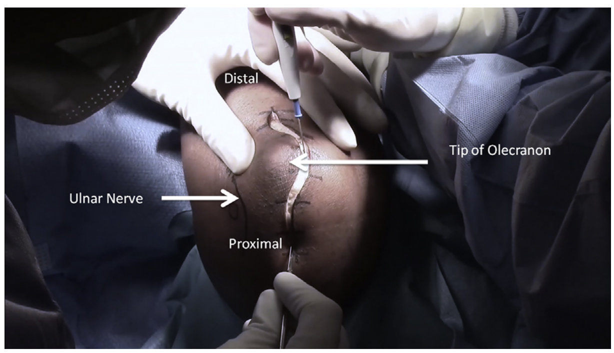

Fig 1. Posterior view of the flexed left elbow with the patient in the supine position demonstrates a lateral curvilinear posterior approach to expose the torn triceps tendon.

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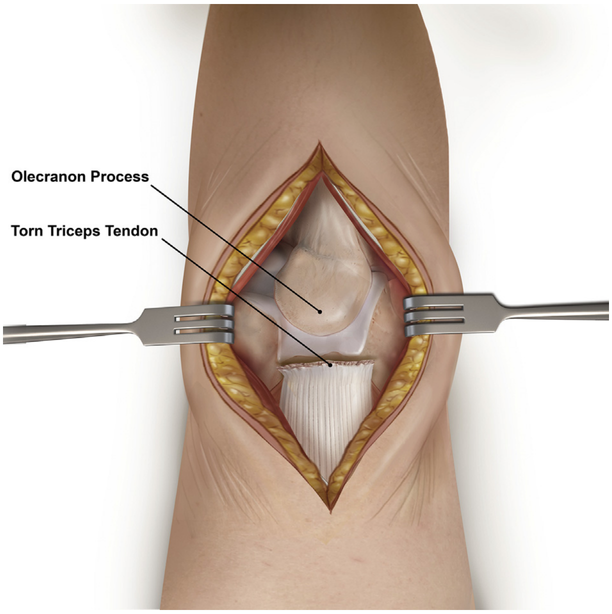

Fig 2. Posterior view of the flexed left elbow demonstrates a posterior approach exposing the torn triceps tendon retracted proximally and the olecranon distally.

hold the arm. After the elbow is prepped and draped in the standard surgical fashion with the inflation of a proximal tourniquet, the elbow is approached through the standard posterior approach with a lateral curvilinear incision (Fig 1). This approach allows wide exposure of the distal triceps and olecranon, protects the ulnar nerve, and avoids placing an incision directly over the posterior olecranon surface. The ulnar nerve is neither fully exposed nor transposed during this approach. The fascia is split inline with the incision, and deep self-retaining retractors (Specialty Surgical Instrumentation, Nashville, TN) are placed to maintain exposure. The triceps is exposed to visualize the musculotendinous junction and mobilized to permit reduction of the tendon to the olecranon (Fig 2).

Table 1. Key Steps in Distal Triceps Speed Bridge Repair

Key Steps
1. Identify and mobilize both the superficial and deep layers of the triceps.
2. Prepare the distal triceps footprint on the proximal olecranon.
3. Confirm adequate footprint for a double-anchor and double-row repair.
4. Prepare the SwiveLock hole initially with an awl and finish with a drill.
5. Confirm adequate tendon length and mobilization for proximal row suture passing.
6. Use a free needle for proximal row suture passing.
7. Tie the proximal row FiberWire in a horizontal mattress configuration.
8. Pass the FiberTape proximal to the FiberWire for a rip stop configuration.
9. Use a criss-cross suture pattern for compression of distal tendon to bone into distal row.

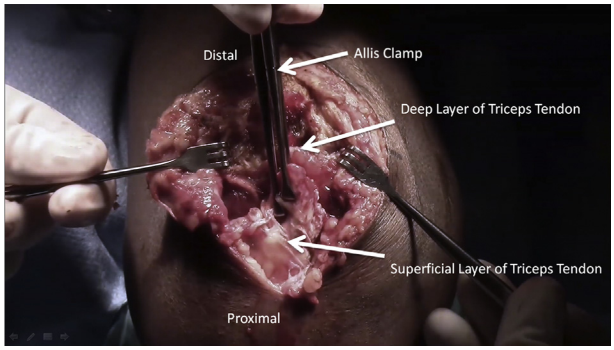

Fig 3. Posterior view of the flexed left elbow with the patient in the supine position demonstrates a posterior approach exposing the delaminated torn triceps tendon retracted proximally. An Allis clamp is used to mobilize the superficial layer.

Special attention is paid to identifying the superficial layer and the deep layer of the distal triceps tendon, as delamination is common with more proximal retraction of the superficial layer (Table 1). We encourage tagging the layers with an Allis clamp (Specialty Surgical Instrumentation) or stitch for ease of traction (Fig 3). Preparation of the distal ends of the triceps for repair is carried out meticulously, and removal of degenerative tissue and calcific deposits is often necessary to expose healthy tendon at the distal end. In chronic cases, mobilizing the tendons with release of proximal adhesions may permit adequate tendon length to cover the entire footprint and provide a tension-free repair.

Attention is then turned to identifying and lightly decorticating the distal triceps footprint in preparation for repair. A handheld burr, curette, and rasp are advantageous in accomplishing this task. Care is taken to roughen the bone to a bleeding surface without penetrating deep into the cancellous layer. Maintaining the

Table 2. Pearls and Pitfalls in Distal Triceps Speed Bridge Repair

Pearls
1. Be mindful of possible delamination and retraction of distal triceps tears.
2. Be mindful of footprint size to determine the number of anchors used in the repair.
3. Use a drill to create SwiveLock holes to avoid potential fracture with an awl.
4. Use a proximal FiberWire horizontal mattress configuration with more proximal FiberTape.
5. Use a criss-cross pattern for compression of tendon with distal row.
Pitfalls
1. Failure to identify or adequately mobilize a retracted superficial layer.
2. Removing too much cortical bone during footprint preparation.
3. Failure to use a drill for anchor hole preparation in dense bone.
4. Attempting to place anchors in close proximity and creating a fracture.
5. Over-tensioning the repair.

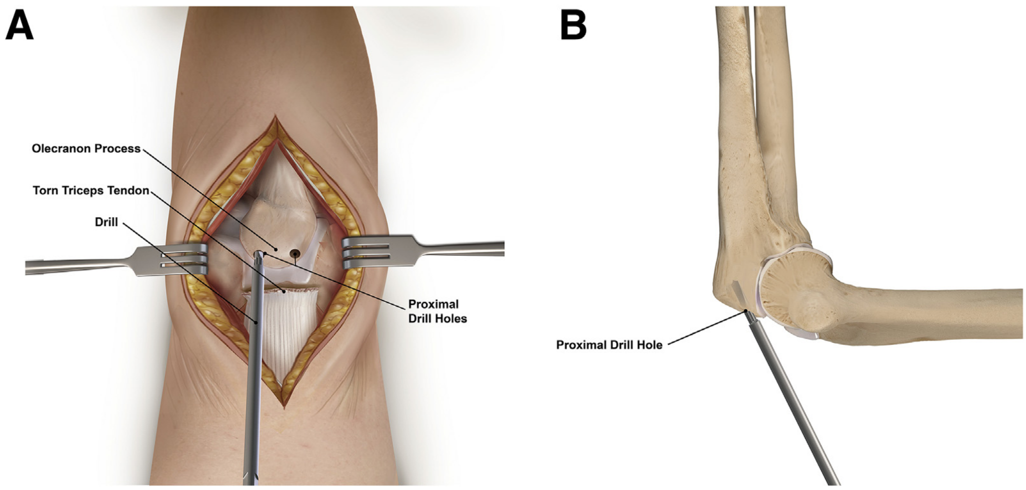

Fig 4. (A) Posterior view of the flexed left elbow demonstrates a drill used to create pilot holes for the proximal anchors within the triceps footprint on the olecranon process. (B) Lateral view of the flexed left elbow demonstrates the proper angle to drill to avoid penetration of the joint surface.

cortical surface for anchor insertion is paramount when preparing for a double-row speed bridge construct, as fracture between anchor holes within a small footprint is a theoretical risk. In our experience, larger males may accommodate 4 total anchors (2 proximal and 2 distal), where as smaller males and females may accommodate only 1 proximal and 1 distal anchor due to the size of the footprint (Table 2).

We initially place our proximal row of anchors. Given the density of the bone, we mark our insertion sites with a starter 4.5-mm Corkscrew awl (Arthrex, Naples, FL) and complete our insertion socket with a 4.0-mm drill (Arthrex; Fig 4). Once the socket has been created, a 4.5-mm Corkscrew tap (Arthrex) is used to ensure ease of anchor insertion in the dense bone. A free FiberTape (Arthrex) is then loaded within the islet of a 4.75-mm double-loaded Bio-SwiveLock anchor (Arthrex) and inserted with the aid of a mallet into the predrilled socket. Once the islet is well seated, the paddle is grasped and maintained in position with 1 hand and the handle is turned clockwise with gentle pressure to screw the anchor into the bone with the other hand. Great care is taken to ensure that the same angle is used to drill and then to insert the anchor for optimal placement and purchase. The procedure is repeated for our second proximal row anchor, which

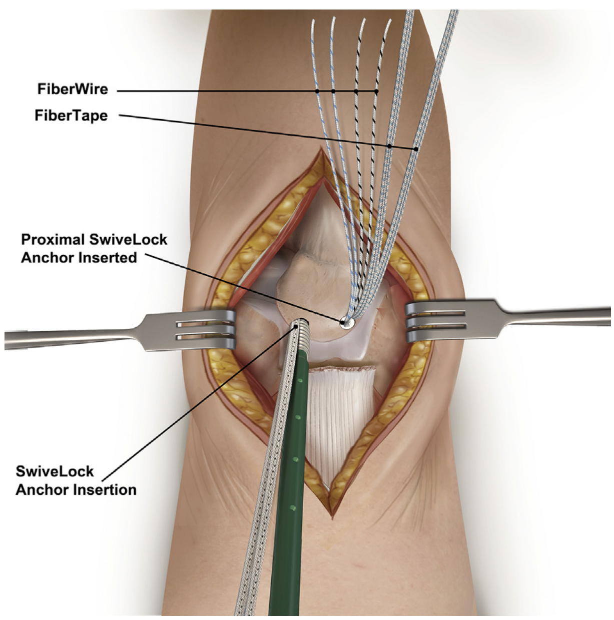

Fig 5. Posterior view of the flexed left elbow demonstrates insertion of the 2 proximal double-loaded anchors with an additional FiberTape in each anchor within the triceps footprint on the olecranon process.

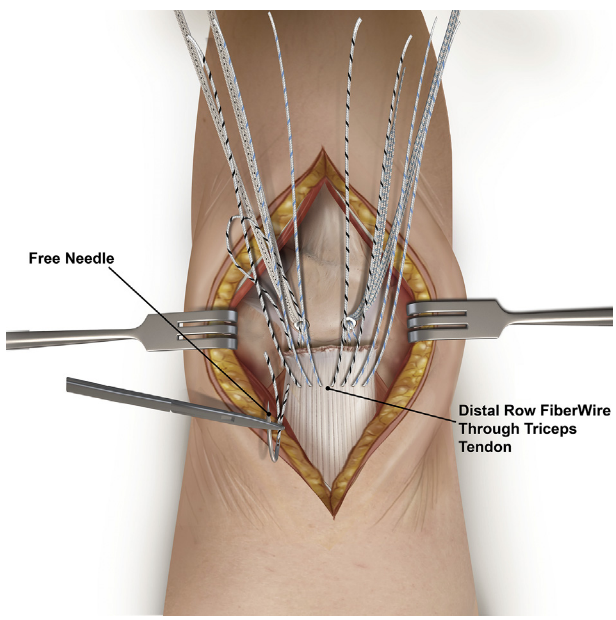

Fig 6. Posterior view of the flexed left elbow demonstrates FiberWire being passed distally through the torn triceps tendon in a horizontal mattress configuration using a free needle in preparation for repair.

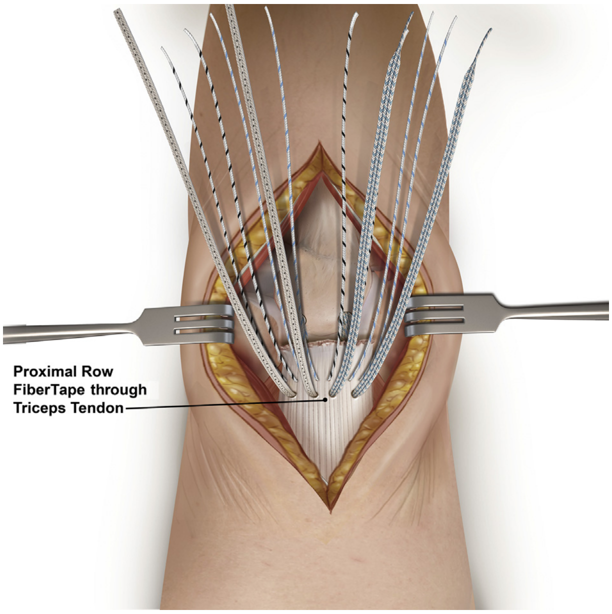

Fig 7. Posterior view of the flexed left elbow demonstrates FiberWire passed distally in a horizontal mattress configuration and FiberTape passed proximally through the torn triceps tendon in preparation for repair.

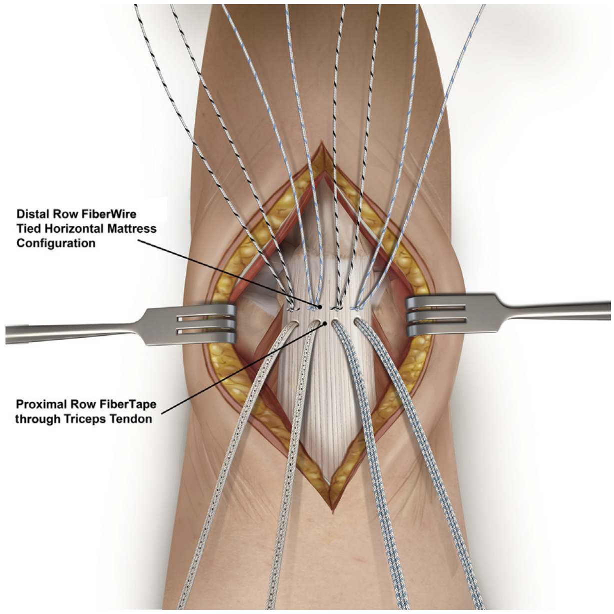

Fig 9. Posterior view of the flexed left elbow demonstrates FiberWire tied distally in a horizontal mattress configuration and FiberTape passed proximally through the torn triceps tendon in preparation for repair.

provides a total of 8 no. 2 FiberWires and 4 FiberTapes for repair (Fig 5). The FiberWire and FiberTape ends are passed through both the deep and superficial layer using a free needle (Anchor Products, Addison, IL; Fig 6). Our preference is to pass the FiberWire sutures in a horizontal mattress configuration and the FiberTape in a more proximal location to provide a biomechanical “rip stop” design (Figs 7 and 8). We prefer to tie the proximal FiberWire mattress row of sutures but leave the FiberTape untied (Fig 9). The elbow may be extended to allow tension-free tying while securing the medial row. During placement of the proximal row, care is taken to ensure adequate tendon length and mobilization for a double-row configuration.

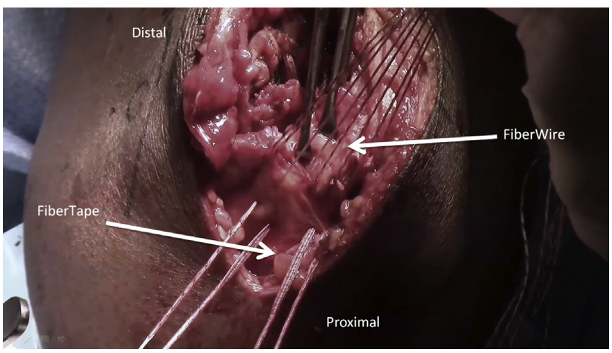

Fig 8. Posterior view of the flexed left elbow with the patient in the supine position demonstrates FiberWire passed distally in a horizontal mattress configuration and FiberTape passed proximally through the torn triceps tendon in preparation for repair.

Once the proximal row has been secured, attention is turned to the distal row of anchors. The insertion sites for the distal 2 anchors are again marked with an awl and drilled (Fig 10). The free ends of the FiberWire and FiberTape are then inserted into the islet of the distal SwiveLock anchors and inserted in the same fashion to complete the repair. Our preference is to insert the sutures from the more medially based proximal row anchor into the more laterally based distal row anchor and vice versa in an effort to create a “criss-cross” pattern for tendon repair and compression (Fig 11). Once the repair is completed, the free suture ends from the distal row are cut flush to the bone with a knife to ensure a low-profile repair (Figs 12 and 13) The elbow is placed through a gentle range of motion to establish adequate postoperative range of motion restrictions. Copious irrigation and meticulous hemostasis are performed prior to a layered closure. A dry sterile dressing is applied along with a sling. The patient remains in a sling until the first postoperative visit at 1 week, where healing of the incision is verified. Postoperative rehabilitation consists of full active extension of the elbow with a gradual increase in flexion of 10° per week under the supervision of a physical therapist. Strengthening is resumed at 6 weeks, and full return to activity is anticipated at 3 months.

Discussion

The innovation of the suture anchor has transformed tendon repair techniques in the field of orthopaedic surgery. Although the majority of attention has been

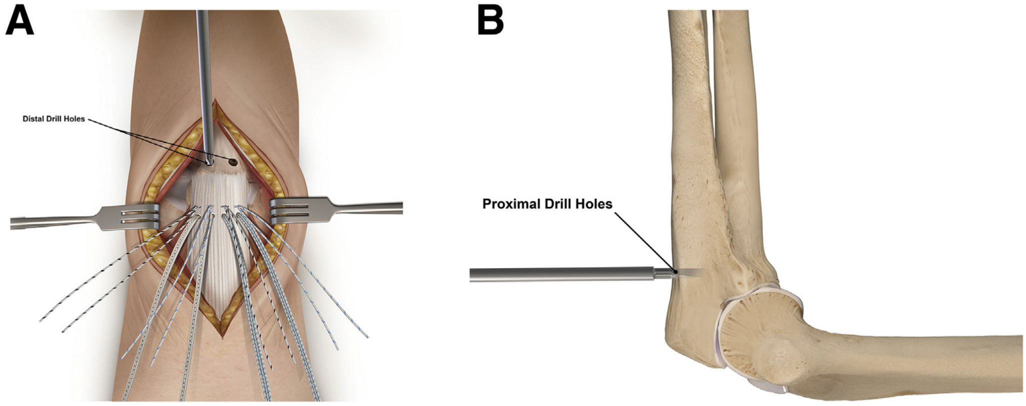

Fig 10. (A) Posterior view of the flexed left elbow demonstrates FiberWire tied distally in a horizontal mattress configuration and FiberTape passed proximally through the torn triceps tendon in preparation for repair. A drill is used to create pilot holes for the distal anchors within the triceps footprint on the olecranon process. (B) Lateral view of the flexed left elbow demonstrates the proper angle to drill.

focused on the rotator cuff and Achilles tendons, triceps tendon repair has evolved as well. Advancements in repair techniques have focused on improvements in anatomic footprint restoration, mechanical strength, and ease of implementation. Our preferred speed bridge technique for triceps repair attempts to incorporate these innovative qualities in an effort to promote surgical advancement for potential clinical benefit.

While basic science research into the distal triceps repair is limited, the rotator cuff model has been studied extensively. Biomechanical studies have clearly demonstrated the advantages of a double-row tendon repair construct compared with single-row constructs.[4,5] Transosseous equivalent or suture bridge repair offers the advantages of an anatomic double-row repair while increasing the strength of the construct and decreasing the length of time required for performing the repair.[6,7] The use of a wider tape in conjunction with more traditional high-strength sutures in a rip stop fashion increases the compressive surface area and pull-out strength of the suture construct.[8]

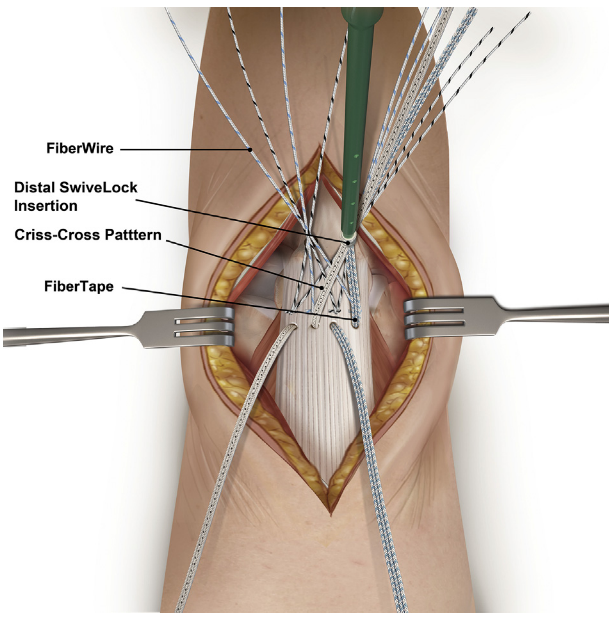

Fig 11. Posterior view of the flexed left elbow demonstrates insertion of the distal row of anchors incorporating the proximal FiberWire and FiberTape in a criss-cross pattern for distal triceps repair.

Anatomic distal triceps repairs have been shown to be biomechanically stronger than more traditional point-fixation or single-row suture anchor repairs.[3,9] This is consistent with the findings of the abundant rotator cuff literature. Although an all-suture anchor transosseous repair has been described for repair of olecranon fractures in the elderly,[10,11] we propose a speed bridge repair of the distal triceps, which provides multiple advantages over the additional techniques (Table 3). Our technique promotes an anatomic repair of the triceps insertion without the need for multiple whipstitches within the tendon, numerous knots, or drill tunnels within the olecranon. It offers the biomechanical benefits demonstrated in the rotator cuff model of stronger fixation over traditional single-row repairs using newer suture technology and suture configurations. Mirzayan et al.[12] recently published the largest series of distal triceps ruptures ever and concluded that transosseous suture fixation of the distal triceps has a significantly higher rerupture rate, higher reoperation rate, and longer release from medical care compared with anchor fixation.

Although the biomechanical and clinical benefits of using suture anchors for repair have been described in the literature, the potential limitations of our technique must be considered. The cost of a suture anchor construct exceeds the expense of simple high-strength sutures and drills. The potential for rerupture

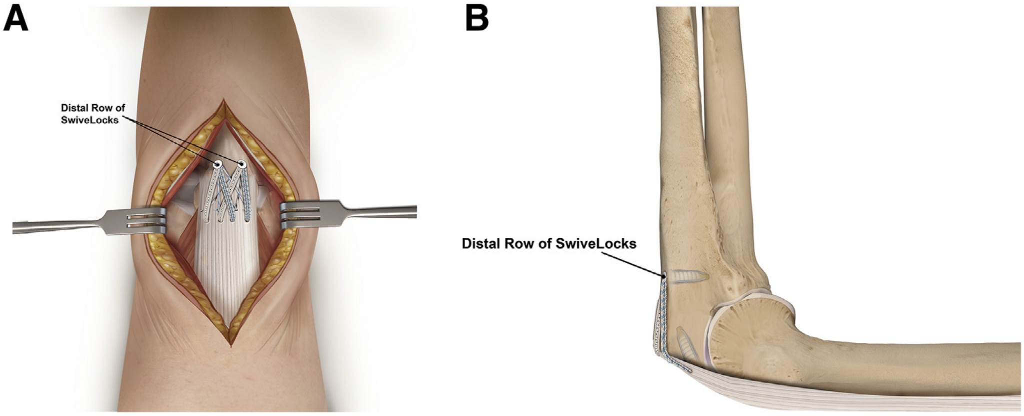

Fig 12. (A) Posterior view of the flexed left elbow demonstrates the final distal triceps repair construct using a speed bridge technique. (B) Lateral view of the flexed left elbow demonstrates the final repair.

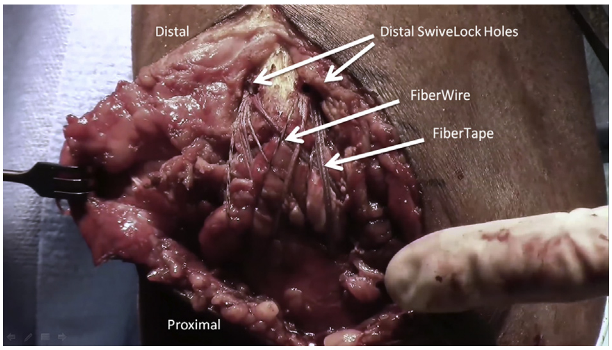

Fig 13. Posterior view of the flexed left elbow with the patient in the supine position demonstrates the final distal triceps repair construct using a speed bridge technique.

Table 3. Advantages and Disadvantages of Distal Triceps Speed Bridge Repair

Advantages
1. Suture anchor repair avoids the need for traditional tunnels.
2. Low-profile repair avoids prominent suture knots on the proximal olecranon.
3. Double-row configuration provides compression of the repaired tendon.
4. Strong initial fixation provides potential for early motion during rehabilitation.
Disadvantages
1. Increased expense compared with traditional suture tunnel techniques.
2. Potential for fracture between anchor holes with small footprint.
3. Potential for type 2 failure pattern with failure of repair.

proximal to the repair with a subsequent type 2 failure pattern is a serious consideration given the repair configuration. Penetration of the elbow joint with iatrogenic injury to the articular cartilage is a concern if the anchors are not inserted at the proper angle. While these risks are minimal, we fully endorse the potential benefits of incorporating suture tape as well as rip stop and criss-cross suture configurations to increase tendon pull-out strength while increasing the compression surface area for better healing.[13,14]

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