## Technical Note

# Arthroscopic Repair of the Triceps Tendon Avulsion—Double-Row Repair

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**Abstract:** Avulsion of the triceps tendon is a rare injury accounting for less than 1% of all tendon injuries. The triceps is an extensor of the elbow and causes compromised function if left untreated. Complete ruptures should be treated with early repairs for satisfactory outcomes. Most of the repair techniques describe transosseous repairs, which do not replicate the footprint anatomy of the triceps insertion. This Technical Note describes an arthroscopic double-row footprint repair for the avulsion of the triceps tendon using all posterior portals.

The triceps tendon comprises the medial, lateral, and long head of triceps.[1] The insertion of the triceps on the olecranon is 13 mm long and 21 mm wide.[2] The deep insertion is 138.1 mm square, and the superficial insertion measures 218.2 mm square[3] (Fig 1 A and B). Commonly used repair methods include open repair using a posterior approach and a transosseous repair using high-strength sutures through the tunnels drilled in the olecranon. Other methods include use of suture anchors and anatomic footprint repairs. Chronic triceps tears may be masked by the olecranon bursitis causing difficulty in tendon repair.[4] Arthroscopic repair of the triceps avulsion includes reduced problems of wound healing, improves cosmesis, and provides better coverage of the triceps footprint. Arthroscopic bursectomy allows for faster recovery compared with open bursectomy.[5]

## Surgical Technique

### Patient Positioning

Under supraclavicular and interscalene block, the patient is positioned in a lateral decubitus position, with care taken to pad the bony prominences of the lower limb and the opposite upper limb (Video 1). The tourniquet is applied, and the elbow is rested on an armrest in 90° of flexion The bony landmarks are marked, and the position of the ulnar nerve is confirmed (Fig 2).

### Portal Placement

The portals are marked, and the procedure is completed by using only the posterior portals. There are 3 main portals: the posterolateral portal (PLP), direct posterior portal (DPP), and the accessory portal for distal row (APFDR). An additional accessory posterolateral portal (APLP) is used for suture management (Fig 3). PLP is a viewing portal to perform a diagnostic round and understand the tear pattern. A diagnostic round is taken of the elbow joint from the posterior ports (Fig 4 A-C). After the diagnostic round, the scope is then shifted to the DPP, and the PLP is used as a working portal.

### Olecranon Bursectomy

Thorough bursectomy is performed to expose the footprint of the triceps tendon on the olecranon process after identifying the triceps tear (Fig 5). The bursal tissue over the olecranon footprint is shaved to expose the bone and freshened for improved tendon healing.

### Tear Pattern Identification and Proximal Row Anchor Placement

The tear pattern is identified, and a hook probe is used to palpate the extent of the tear. The proximal row anchor position is marked 7 to 10 mm distal to the tip of the olecranon process (Fig 6 A and B). The footprint area is debrided to expose the bone and the insertion

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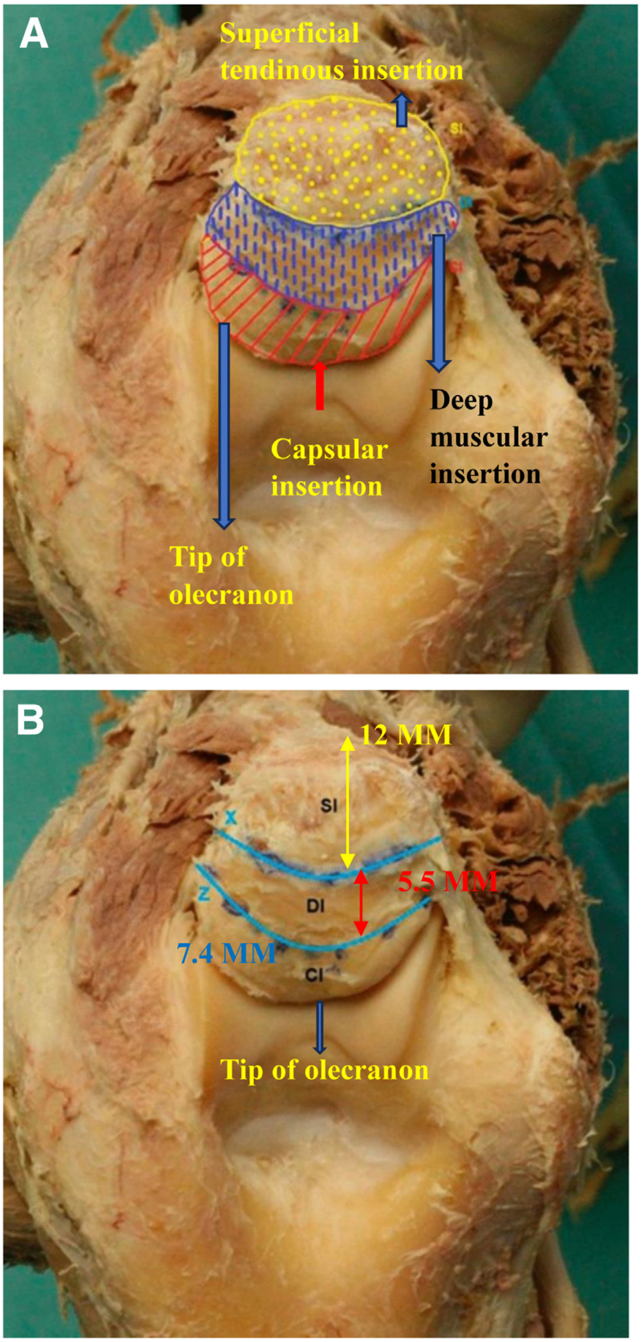


**Fig 1.** (A) A cadaveric dissection of the olecranon footprint of the triceps tendon. The red zone is the capsular attachment, the blue zone is the deep muscular attachment, and the yellow zone is the superficial tendinous attachment. (B) The blue arrow indicates the tip of the olecranon process. Cl, line of capsular attachment from the tip of olecranon; Dl, deep insertion (muscular); Sl, superficial tendinous line and their measurements in millimeters.

site is marked with radiofrequency probe. A 2.8-mm single-loaded titanium anchor (Biotek India) is inserted for the proximal row repair and is confirmed on fluoroscopy (Fig 6 C-E).

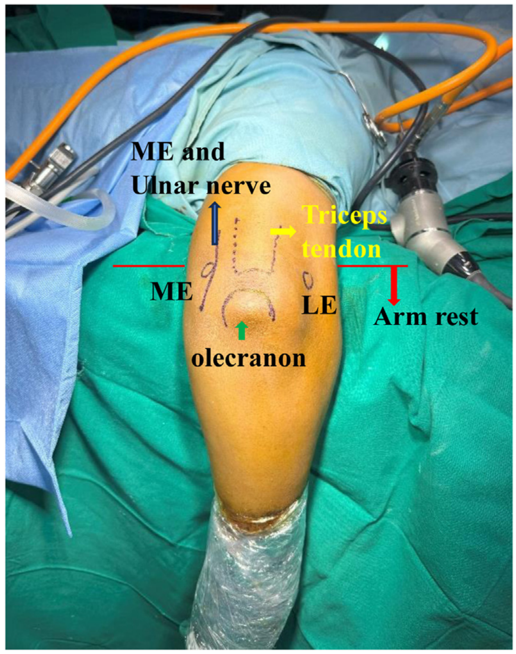


**Fig 2.** Patient positioning and anatomic landmarks. The patient is in lateral position with right elbow resting on an arm rest (red line) at 90° flexion. Bony landmarks: blue arrow, ulnar nerve; green arrow, olecranon process; LE, lateral epicondyle; ME, medial epicondyle; yellow arrow, outline of triceps tendon.

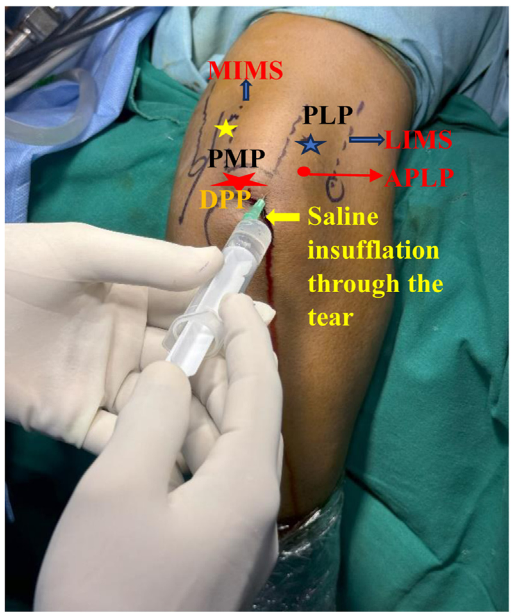


**Fig 3.** Patient in lateral position and elbow at 90° flexion with portals marked. A 10-cc syringe with a No. 21 needle is used to insufflate the elbow joint with 20 cc of normal saline from the soft spot. The red star indicates the direct posterior portal (DPP); the blue star indicates the posterolateral portal (PLP); the red circle indicates the accessory posterolateral port (APLP); the yellow star indicates the posteromedial port (PMP). LIMS, lateral intermuscular septum; MIMS, medial intermuscular septum.

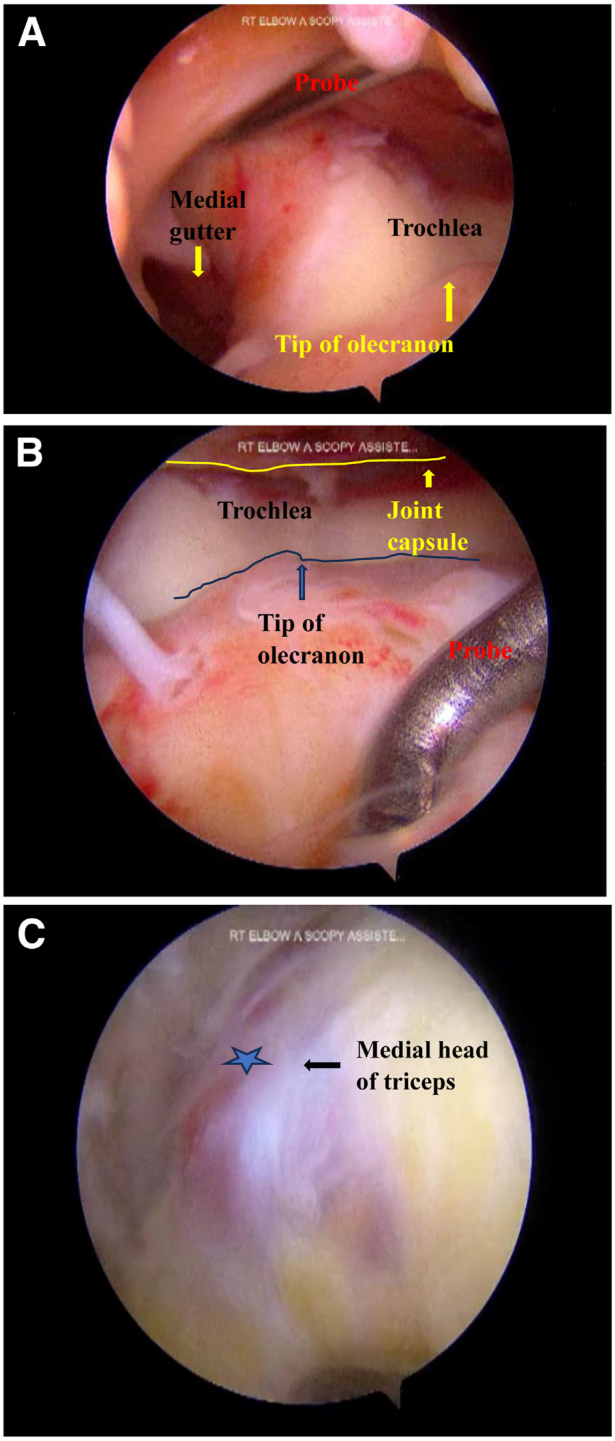


**Fig 4.** (A) Right elbow at 90° of flexion viewed through the direct posterior portal (DPP) and probe from the posterolateral portal (PLP) showing a diagnostic round with probe in the medial gutter. The yellow arrow indicates the tip of olecranon and the trochlea. (B) Right elbow at 90° flexion viewed through the DPP and probe from the PLP. Blue line, tip of the olecranon process with probe on the footprint of triceps; yellow line, margin of the articular capsule. (C) Right elbow at 90° flexion viewed through the DPP, showing the musculotendinous junction. Blue star, medial head of triceps.

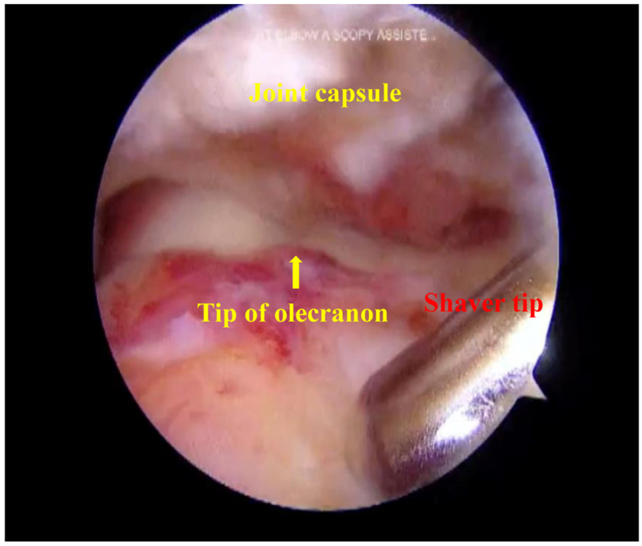


**Fig 5.** Right elbow at 90° flexion viewed through the direct posterior portal and shaver tip from the posterolateral portal. Shown are the tip of olecranon, the joint capsule, and shaver (3.5-mm Dyonics; Smith & Nephew) performing a bursectomy.

### Creating Accessory Lateral Portal

An accessory lateral portal is created just distal to the PLP, and a plastic cannula (the sheath of a spinal needle) is inserted for suture management (Fig 7). The suture ends are parked in this canula.

### Taking Bites Through the Tendon

An antegrade suture passing device (Firstpass Mini; Smith & Nephew) is used to take the bite through the torn tendon including the joint capsule from the DPP. The same step is repeated with the other end to tie the proximal row in the mattress configuration (Fig 8 A-C).

### Preparation of the Distal Row

The distal row fixation point is marked under fluoroscopy control perpendicular to the olecranon margin (Fig 9A). A stab incision is made, and the footprint prepared with the radiofrequency device (Fig 9B). A guidewire for a 3.5-mm knotless anchor 13.5 mm in length (DX Swivelock 3.3 × 13.5 mm; Arthrex) is drilled and confirmed on fluoroscopy (Fig 9 C and D).

### Distal Row Fixation

The proximal row sutures are retrieved from the DPP pilot hole confirmed, and a 3.5 × 13.5 mm knotless anchor (DX Swivelock 3.3 × 13.5 mm; Arthrex) is inserted with the elbow in full extension (Fig 10 A-C).

### Additional Proximal Row Fixation

The distal anchor used is 3.5 mm in diameter and does not accommodate 4 suture strands through the eyelet; therefore, an additional safety anchor was used on the proximal row in a single-row fashion to achieve

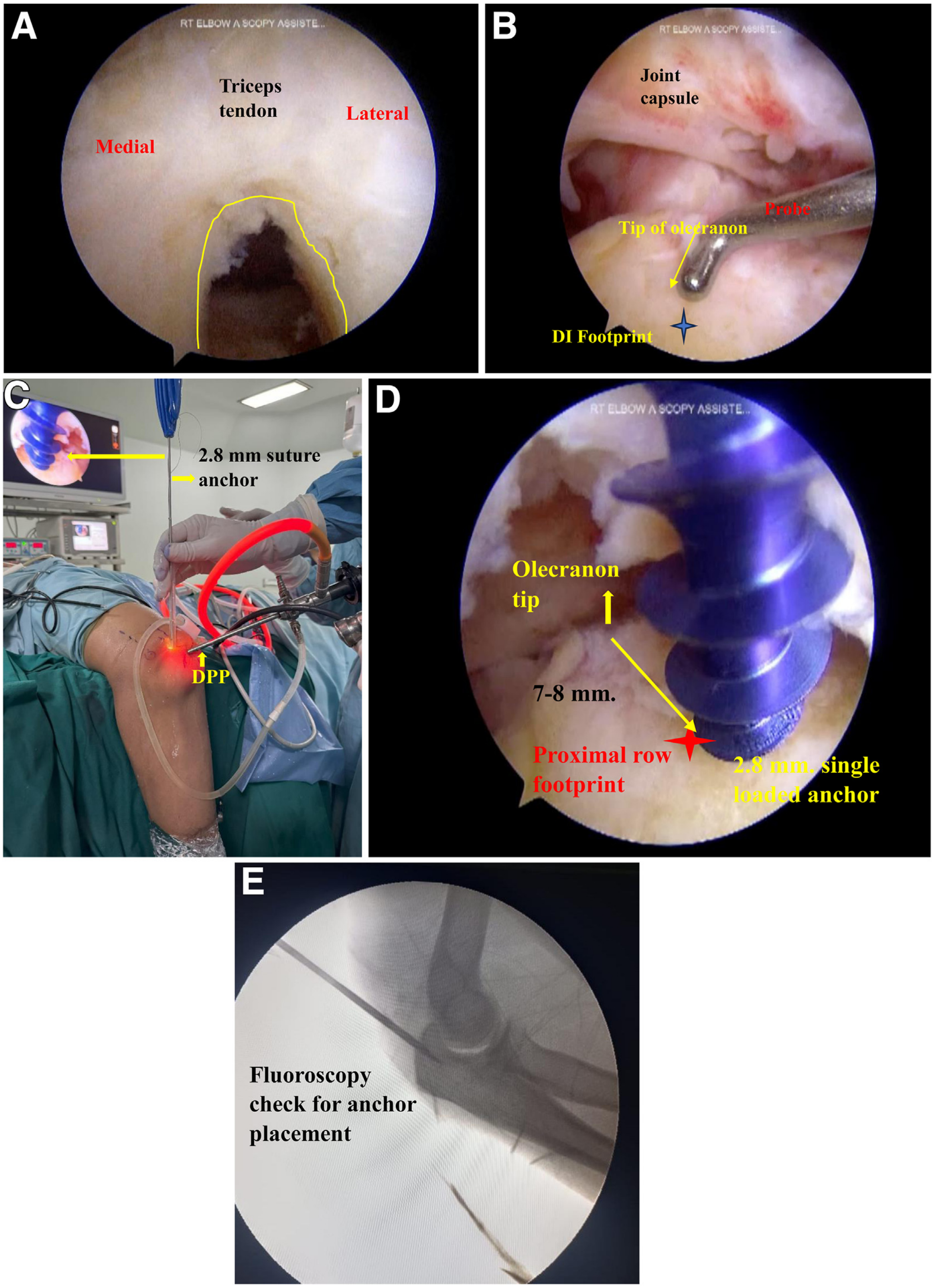


**Fig 6.** (A) Right elbow at 90° flexion viewed through the direct posterior portal (DPP). The yellow line shows the tear configuration and the triceps tendon. (B) Right elbow at 90° flexion viewed through the DPP and the probe from the posterolateral portal (PLP). The method for measuring the distance of proximal footprint is shown (the tip of the probe is 4 mm in length and deep insertion [DI; blue star] insertion is 7.4 mm from the tip). The point of proximal anchor placement is twice the length of probe. (C) Right elbow at 90° flexion viewed through the DPP and the suture anchor (2.8 mm titanium) from the PLP. The anchor insertion is shown in line with the olecranon tip. (D) Right elbow at 90° flexion viewing through the DPP and the suture anchor (2.8 mm titanium) from the PLP. The anchor insertion in line with the olecranon tip is shown. The yellow arrow indicates the distance of the anchor placement for the proximal row from the olecranon tip. (E) A fluoroscopy check for the precise anchor placement.

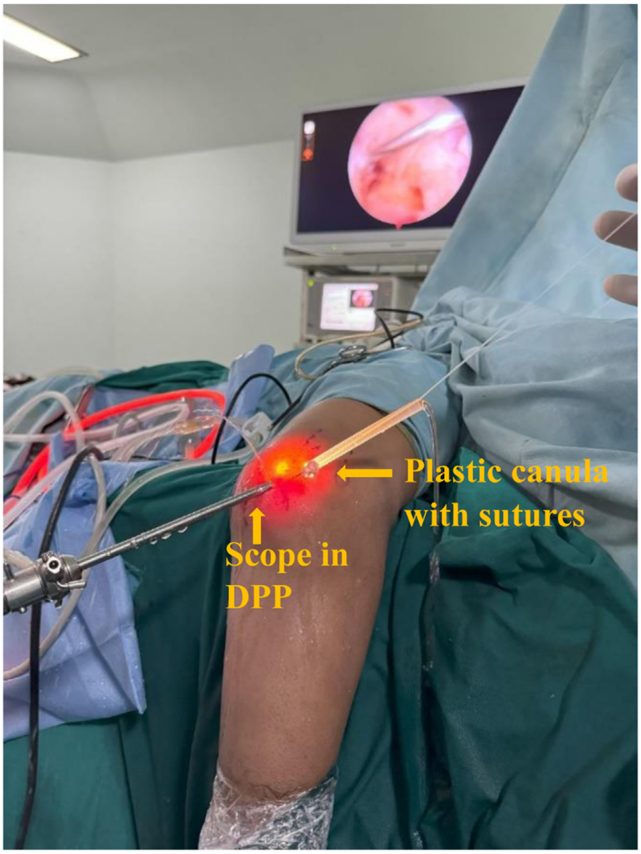


**Fig 7.** Right elbow at 90° flexion viewed through the direct posterior portal and transparent spinal needle sheath with sutures from the posterolateral portal (PLP). Retrieval of sutures from the PLP for suture management is shown.

an adequate footprint coverage using fluoroscopy control (Fig 11 A-C).

### Completed Repair

The repair is completed (Fig 12), and the portals are closed (Fig 13). The limb is protected in a posterior slab for 3 weeks.

### Postoperative Rehabilitation

The elbow is rested at 90° of flexion. Finger movements with active shoulder movements are started immediately. After suture removal at 3 weeks, the limb is protected in a hinged functional cast brace. Active elbow movements are started eliminating the gravity and progresses in phases until unprotected movements are allowed at 16 weeks.

## Discussion

Distal triceps injuries account for less than 1% of all tendon injuries in the upper extremities.[6] Most commonly requiring surgical treatment, they are treated with open posterior approach and refixation of the triceps tendon to the olecranon process. Recent development in arthroscopic techniques has enabled us

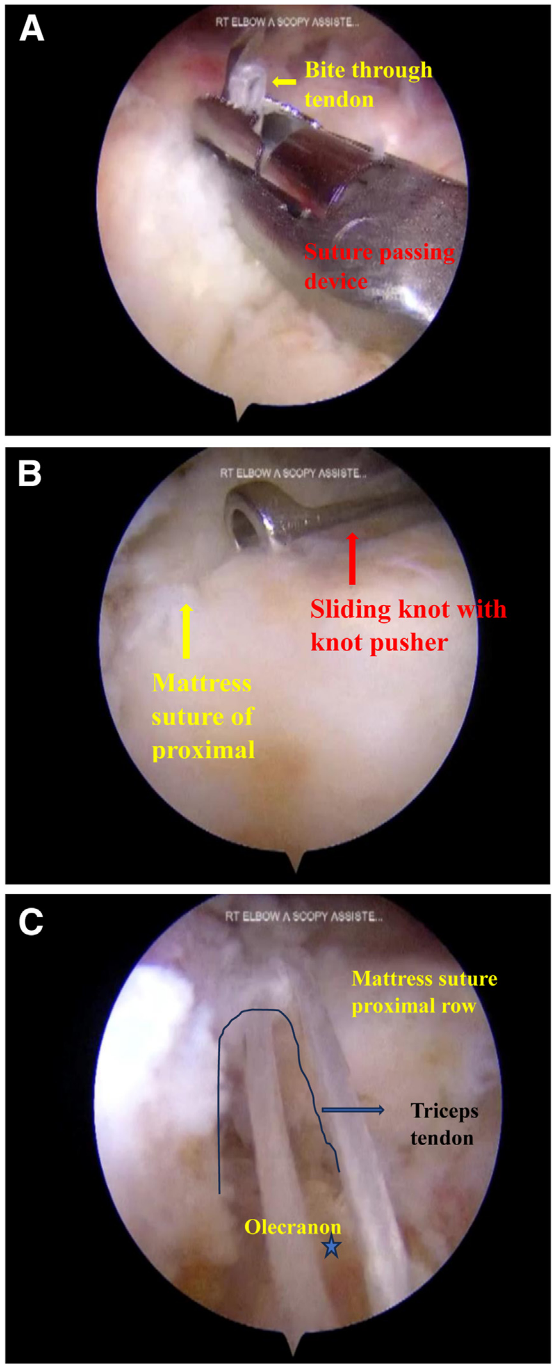


**Fig 8.** (A) Right elbow at 90° flexion viewing through the direct posterior portal (DPP) and an antegrade suture passing device (Firstpass Mini; Smith & Nephew) through the posterolateral portal (PLP); The first bite through the tendon, including the articular capsule, is shown. Right elbow at 90° flexion is viewed through the DPP. A knot pusher from the PLP and completion of a suture with mattress configuration is shown. (C) Right elbow at 90° flexion viewed through the DPP. Completed proximal row repair and the sutures for a distal row repair are shown.

to perform arthroscopic double-row repair of the triceps tendon. The distinct advantages of this technique are

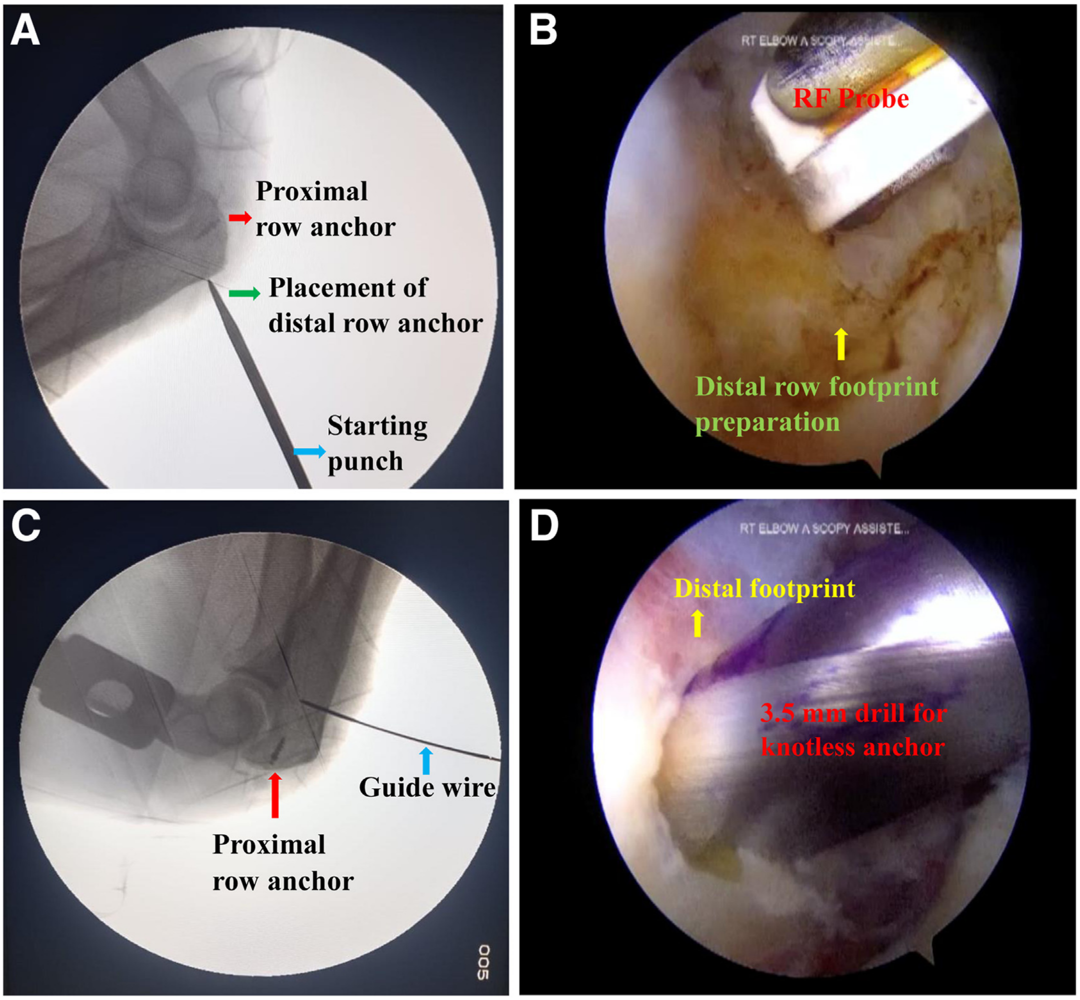


**Fig 9.** (A) A fluoroscopy check for deployment of the distal row anchor with a starting punch to mark the point of insertion. The red arrow indicates proximal row anchor. (B) Right elbow at 90° flexion viewing through the direct posterior portal (DPP). The radiofrequency (RF) device from the posterolateral portal for preparation of the footprint of the distal row is shown. (C) A fluoroscopy check is performed for deployment of the distal row anchor with a guidewire drilled for a 3.5-mm knotless anchor at the point of insertion. The red arrow indicates proximal row anchor, and the blue arrow shows the guidewire in place. (D) Right elbow at 90° flexion viewed through DPP. A cannulated drill bit is shown drilling over the guidewire. The blue mark is at 13.5 mm for insertion of the knotless anchor.

anatomic coverage of the triceps footprint, allowing more surface area for healing; decreased wound complications; better cosmesis; and dealing with the concomitant intra-articular pathologies (Table 1). Despite these advantages, there are certain disadvantages because it cannot be used for mid-substance tendon injuries, olecranon bursa may make visualization difficult, and the portal placement is critically important for successful surgery. In a cadaveric biomechanical study on 27 cadavers comparing 3 methods of the repair, Yeh et al.[7] reported that the amount of displacement on cyclical loading was least in anatomic repair. Anatomic repair also covered the maximum footprint (86%) compared with other repair methods. The repair methods studied were divided into 3 groups: (1) transosseous cruciate repair, (2) use of 2 metal anchors (4.5 mm), and (3) transosseous equivalent anatomic footprint repair.

Constantino et al.[8] reported 2 cases treated by open anatomic footprint repair using a speed bridge configuration with 4.75-mm biocomposite anchors with a good outcome. These anchors were 19.5 mm in length, which may cause penetration of the ulnohumeral articulation. Hence, we have used a knotless anchor that is 13.5 mm in length (Table 2).

In another cadaver study,[9] it was reported that the failure of the repair occurred mostly in the transosseous group after cyclical loading. The mechanism of failure in the transosseous group was due to knot slippage; in the hybrid group, the tunnels failed with a fracture; and no failure was reported at the bone-anchor interface, proving superiority of this repair technique.

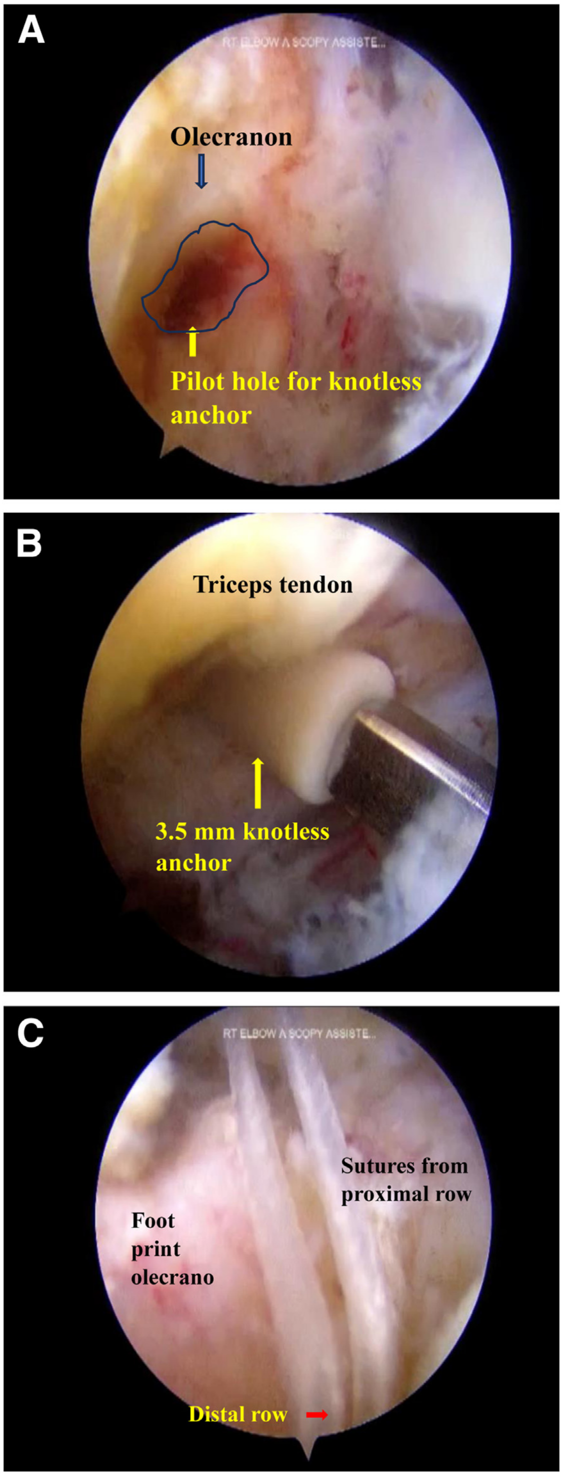


**Fig 10.** (A) Right elbow at 90° flexion viewed through the direct posterior portal (DPP). A pilot hole for insertion of the distal row anchor is shown. (B) Right elbow at 90° flexion viewed through the DPP. The insertion of a knotless anchor (DX Swivelock 3.3 × 13.5 mm; Arthrex) for distal row repair is shown. (C) Right elbow at 90° flexion viewed through the DPP. Sutures from the proximal row with complete coverage of the olecranon footprint are shown.

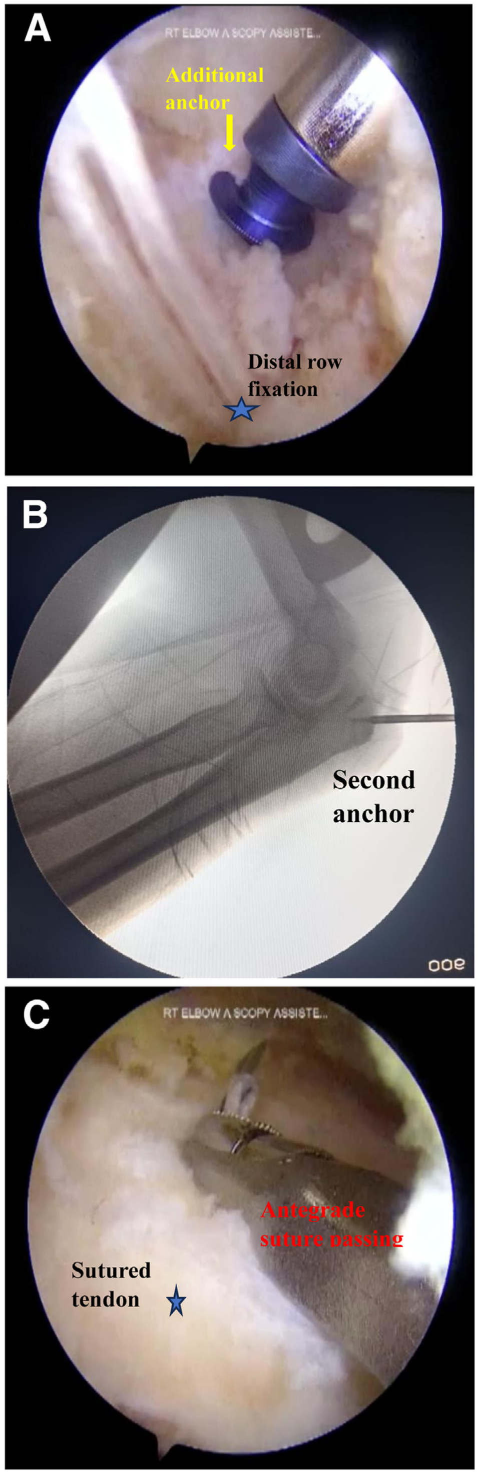


**Fig 11.** (A) Right elbow at 90° flexion viewed through the direct posterior portal (DPP). Insertion of additional proximal row anchor through the posterolateral portal (PLP) is shown. (B) Fluoroscopy image of the insertion of the second anchor for proximal row. (C) Right elbow at 90° flexion viewed through the DPP. The antegrade suture passing device (Firstpass Mini; Smith & Nephew) through the PLP is shown taking a bite through the tendon.

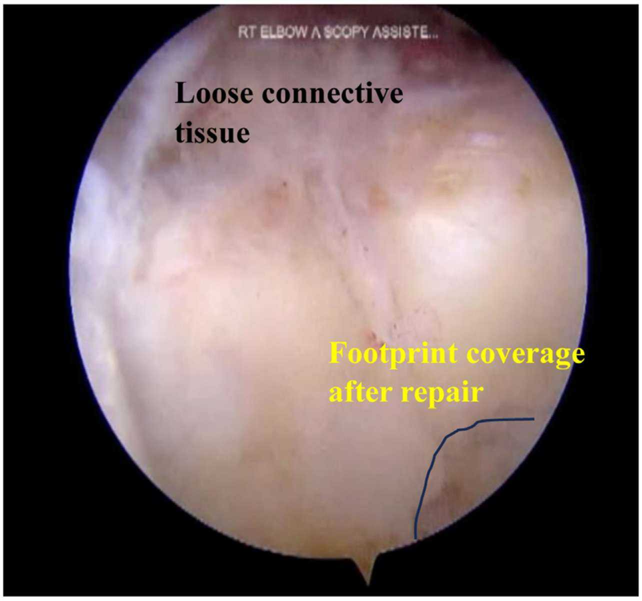


**Fig 12.** Right elbow at 90° flexion viewed through the direct posterior port. The completed repair with total coverage of the footprint is shown.

In a review article comparing suture anchor fixation with transosseous bone tunnel fixation, it was reported that the overall complications with suture anchor fixation was low, and the overall satisfaction rate was 95%.[10]

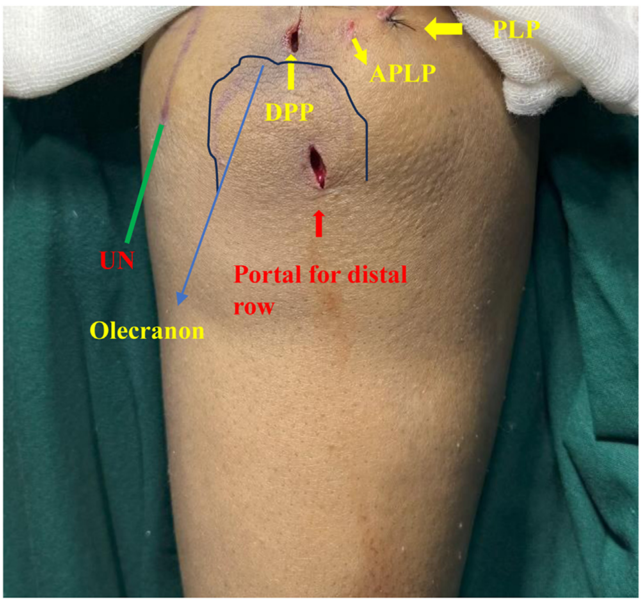


**Fig 13.** Right elbow at 90° flexion. The portals being closed and their positions after the repair are shown. APLP, accessory posterolateral port; DPP, direct posterior port; PLP, posterolateral port; UN, ulnar nerve. The blue arrow indicates the olecranon process, and the red arrow shows a port for the distal row.

**Table 1.** Advantages and Disadvantages of the Technique

| Advantages | Disadvantages |
|---|---|
| • Decreased wound complications<br>• Improved cosmesis<br>• Complete footprint coverage<br>• Can deal with concomitant intra-articular pathologies<br>• Early rehabilitation | • Needs specialized instruments<br>• There is a learning curve |

**Table 2.** Pearls and Pitfalls

| Pearls | Pitfalls |
|---|---|
| • Thorough bursectomy is crucial for proper visualization.<br>• Use of a 2.8-mm proximal row anchor prevents stress riser.<br>• A 2.8 mm meatal anchor helps insertion under fluoroscopy.<br>• Use of a 3.5 × 13.5 mm knotless anchor reduces the chance of olecranon fracture during insertion.<br>• Portal placement should be accurate. | • Insertion of the knotless anchor can be difficult due to dense bone in the olecranon.<br>• Utmost care is needed while using an antegrade suture passing device to avoid the ulnar nerve. |

In the technique presented here, we used a 2.8-mm single-loaded titanium anchor (Biotek India) for the proximal row repair and a 3.5 mm × 13.5 mm anchor (DX Swivelock 3.3 × 13.5 mm; Arthrex), which eliminates the risk of intra-articular penetration.

## Disclosures

The authors (M.V.P., H.G.P) 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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