Technical Note

Arthroscopic-Assisted Inside-Out Foveal Reattachment of Triangular Fibrocartilage Complex

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Abstract: The dorsal and palmar radioulnar ligaments are the deep components of the triangular fibrocartilage complex (TFCC), which provides stability to the distal radioulnar joint (DRUJ). In patients with DRUJ instability, arthroscopic procedures are currently focused on reattachment of the deep components of the TFCC to the fovea of the ulnar head. TFCC—foveal reattachment can be performed either by using the transosseous technique with creation of a bone tunnel or by suturing to a bone anchor. Most previous studies of the TFCC suture method have used an outside-in technique. We herein present an arthroscopic inside-out TFCC—foveal reattachment technique with a bony anchor for the treatment of DRUJ instability. This technique has novel advantages, including less exposure, less soft-tissue dissection, and greater ease of TFCC suturing. This procedure may thus be considered another good option for the treatment of TFCC injury with DRUJ instability.

The triangular fibrocartilage complex (TFCC) is the principal ligamentous stabilizer of the distal radioulnar joint (DRUJ). The stability of the distal radioulnar joint mainly relies on insertion of the deep component of the TFCC (i.e., the distal radioulnar ligament) at the foveal area of the ulnar head.[1-3]

Patients with DRUJ instability present with ulnar wrist pain, clicking, and loosening as well as lessening of grip strength. The main physical examination findings include tenderness of the ulnar fovea (ulnar fovea sign)[4] and an abnormal DRUJ ballottement test result.[3]

In repairable cases, foveal repair or reattachment of the TFCC is the crucial surgery to restore DRUJ stability. This can be performed by suturing the deep component of the TFCC to the foveal insertion site over the ulnar head.[3,5-12] Previous reports have described the outside-in TFCC suturing technique for foveal reattachment, accessing the TFCC from a mini-open approach at the base of the ulnar styloid.[5,7,8,10,11] However, few reports have described the inside-out technique.[6,12] Thus, we herein present our technique of arthroscopic-assisted inside-out foveal reattachment of the TFCC.

Diagnosis and Indications for Surgery

The diagnostic criteria for TFCC injury with DRUJ instability are as follows: (1) positive ulnar fovea sign[4]; (2) positive DRUJ ballottement test,[3] classified as none, mild, moderate, or severe instability by the Moritomo classification[9]; and (3) increased signal intensity over the foveal area of the distal ulna on magnetic resonance imaging.

The indications for surgery are as follows: (1) either mild-to-moderate DRUJ instability with nonresponse to conservative treatment by long arm cast immobilization for 4 to 6 weeks or the presence of severe DRUJ instability; (2) positive ulnar-sided detachment of the TFCC (hook test) or foveal disruption via wrist arthroscopy[5]; and (3) a repairable TFCC tear. Contraindications for this procedure are wrist deformity; local or systemic arthritis involving the distal radioulnar joint; and a degenerative, irreparable TFCC (Table 1).

Surgical Technique (With Video Illustration)

Arthroscopic-assisted inside-out TFCC foveal reattachment is described in a step-by-step manner below and is shown in Video 1. Tips and tricks are presented in Table 2.

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Table 1. Indications and Contraindications of the Technique

Indications
TFCC with DRUJ instability
Failed conservative treatment
Positive TFCC foveal disruption via wrist arthroscopy (hook test)
Repairable TFCC tear
Contraindications
Wrist deformity or arthritis involving the distal radioulnar joint
Degenerative, irreparable TFCC

DRUJ, distal radioulnar joint; TFCC, triangular fibrocartilage complex.

Position and Setup

Under regional or general anesthesia and tourniquet control, the patient is placed in the supine position. The patient's wrist is distracted 10 to 15 lb by a wrist traction tower. The standard 3-4, 4-5, and 6R portals are created on the dorsal wrist. The radiocarpal and ulnocarpal joints are thoroughly examined using wrist arthroscopy via the 3-4 portal. The TFCC tension and the foveal insertion stability are evaluated by the trampoline test and hook test using a probe via the 6R portal.

Table 2. Tips and Tricks

1. The ulnar incision over the ulnar fovea soft spot should be placed more volar from the mid-ulnar region for ease of suture passing and retrieving from the suture lasso.
2. The dorsal branch of the ulnar nerve should be identified and protected with the surrounding fatty tissue to lessen the nerve injury from retraction.
3. Semisupination of the wrist should be performed from the mini-open approach at the ulnar wrist to access and prepare the foveal footprint via the DF portal.
4. Preparation of the ulnar fovea footprint can be performed via the 6R portal through the prestyloid recess or DF portal from the mini-open approach.
5. Foveal footprint preparation is performed with a small joint shaver, burr, or curette in the dorsoradial to volarulnar direction of the ulnar wrist for wide attachment of the deep component of the TFCC to the fovea.
6. TFCC capsular synovitis and hypertrophy should be debrided and shrunk to attain a smooth capsular edge and thus easily identify and delineate the suture location.
7. The TFCC suture should be wide enough to capture the TFCC tissue for a large contact area at the footprint and prevent the TFCC cut-through suture.
8. A curved, 70° Micro SutureLasso (Arthrex) should be used to pass the suture and help direct the suture through the DF portal.
9. The tip of the suture lasso is passed through the opened window of the ulnar capsule–retinaculum incision; thus, the TFCC suture can be attached to the fovea without incarceration of the capsule.
10. The K-wire should be switched from the 1.6-mm wire (for a 2.5-mm pushlock anchor) or 2.0-mm wire (for a 2.9-mm PushLock anchor) to the smaller temporary 1.2-mm wire while retaining the K-wire sleeve for ease of quick switching from the K-wire to the PushLock anchor (without using a motorized device).
11. The ulnar DRUJ capsule should be dissected clearly enough to accurately insert the PushLock anchor at the fovea.
12. The wrist traction is released while performing the DRUJ reduction and securing the anchor in the neutral wrist position.

DF, direct fovea; DRUJ, distal radioulnar joint; TFCC, triangular fibrocartilage complex.

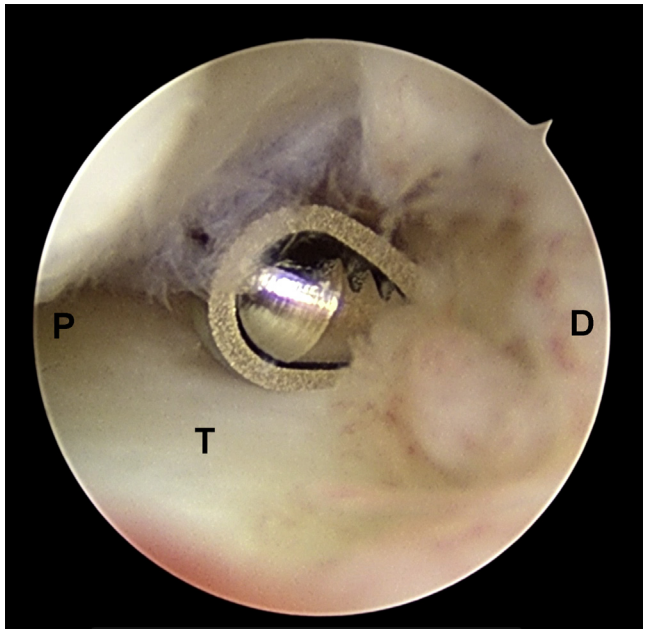

Fig 1. Debridement of the dorsoulnar synovitis and synovial hypertrophy to clarify the dorsal edge of the TFCC. Right wrist; viewing portal 3-4; shaver via 6R portal. (D, dorsal; P, palmar; T, triangular fibrocartilage complex.)

Arthroscopic Debridement and Foveal Preparation

TFCC capsular fraying, synovitis, or fibrovascular granulation tissue is debrided using a 2.9-mm small joint shaver (CONMED, Utica, NY) and shrunk using a radiofrequency probe (Arthrex, Naples, FL) via the 6R

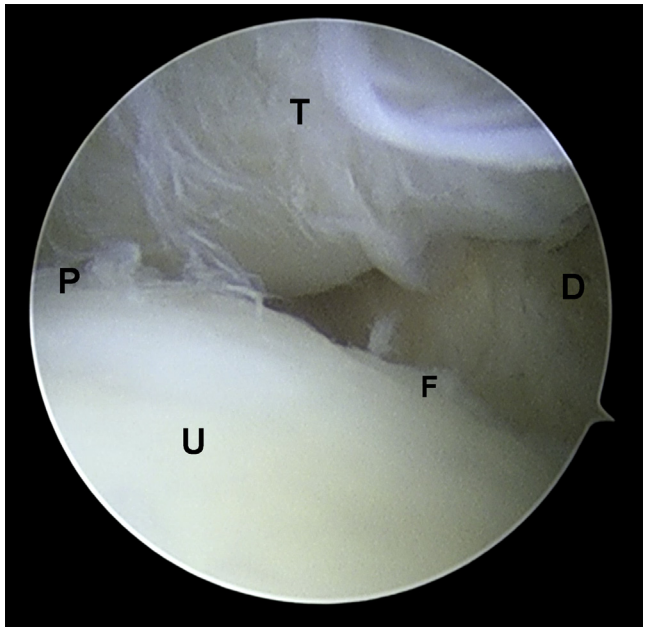

Fig 2. Evaluation of the deep component of the TFCC and the foveal insertion site, demonstrating avulsed deep component of TFCC. Right wrist; viewing from DRUJ portal. D, dorsal; F, fovea; P, palmar; T, avulsed triangular fibrocartilage complex; U, ulnar pole.)

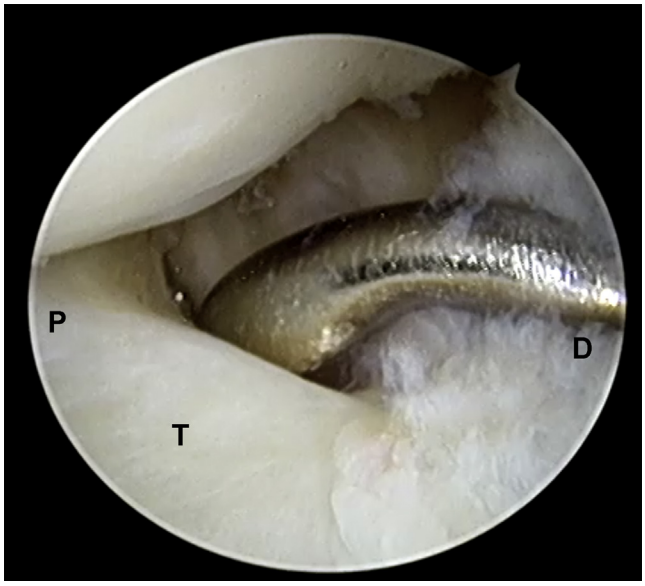

Fig 3. Preparation of the foveal footprint using a curette via the prestyloid recess. Right wrist; viewing portal 3-4; curette via 6R portal. (D, dorsal; P, palmar; T, triangular fibrocartilage complex.)

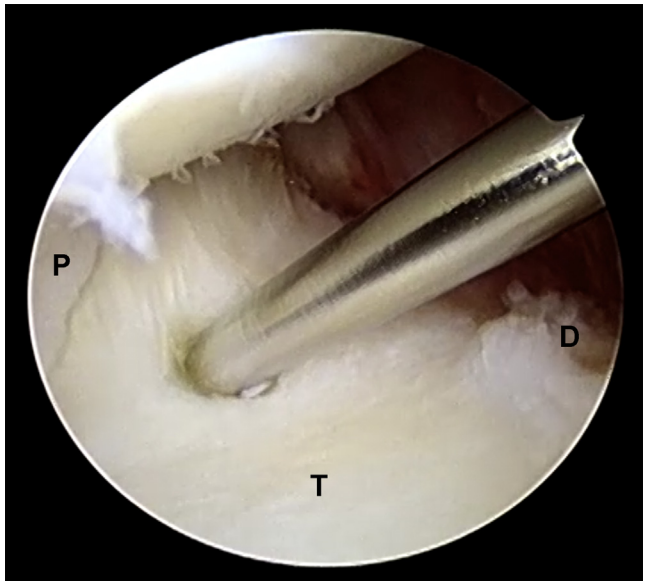

Fig 5. TFCC palmar suture passing with the Micro SutureLasso via the 4-5 portal. Right wrist; viewing portal 3-4. (D, dorsal; P, palmar; T, triangular fibrocartilage complex.)

portal (Fig 1). The foveal insertion can be directly evaluated via the DRUJ portal (Fig 2). The foveal footprint is prepared for foveal reattachment by debridement of the granulation tissue and ligamentous remnants through the 6R portal. With arthroscope at the 3-4 portal, foveal preparation also can be performed through prestyloid recess using a small joint shaver, burr, and curette via the 6R portal (Fig 3).

Ulnar Approach

A 1.5- to 2.0-cm longitudinal incision is created on the ulnar wrist over the 6U portal area. The dorsal branch of the ulnar nerve is identified and protected. The extensor retinaculum and ulnar DRUJ capsule are incised longitudinally. In the semisupine position, the direct fovea (DF) portal is created to access the ulnar fovea at the radial aspect of the ulnar styloid.[5]

Fig 4. Foveal preparation using a small joint shaver via the DF portal while monitoring with an arthroscope via the DRUJ portal. (DF, direct fovea; DRUJ, distal radioulnar joint.)

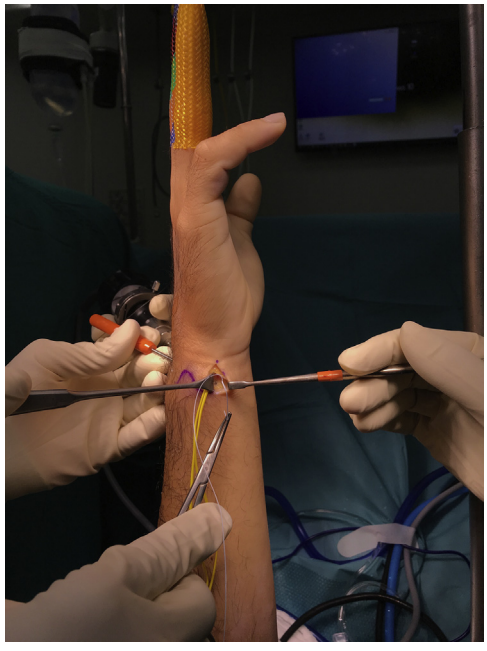

Fig 6. Passing the Micro SutureLasso through the DF portal and retrieval of the suture from the ulnar wrist approach. (DF, direct fovea.)

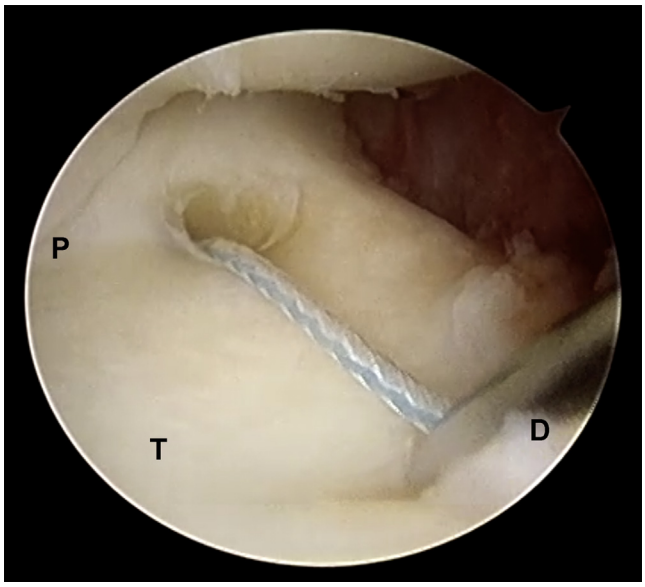

Fig 7. View from the 3-4 portal of the right wrist demonstrating the horizontal mattress suture passing via the 4-5 portal. (D, dorsal; P, palmar; T, triangular fibrocartilage complex.)

Preparation of the foveal footprint also can be performed via DF portal, while monitoring with arthroscopy at DRUJ portal (Fig 4).

TFCC Suture Passing

A 70° Micro SutureLasso (Arthrex) is inserted through the 4-5 portal. The SutureLasso is passed through the palmar TFCC edge radial to the prestyloid recess while aiming through the DF portal (Fig 5). The 2-0 FiberWire (Arthrex) is retrieved and passed from the palmar suture location through the dorsal suture location in a horizontal mattress, inside-out fashion (Figs 6-8).

Anchor Insertion

A 1.6- or 2.0-mm Kirschner wire (K-wire) is inserted to the foveal insertion site via the DF portal to prepare the anchor site. Two tails of the suture are passed through the eyelet of a 2.5- or 2.9-mm knotless suture anchor (Mini PushLock; Arthrex) (Fig 9). The wrist traction is released, and the ulnar head is reduced to the sigmoid notch and maintained in the neutral forearm position. The anchor is inserted at the K-wire hole while the suture tails are pulled tightly to secure the repair (Figs 10 and 11). The ulnar capsule and retinacular repair are performed with the pant-over-vest technique.

Postoperative Rehabilitation Protocol

The patient is immobilized in an above-elbow slab in the neutral wrist position for 1 week. After suture removal, a Muenster-type cast or splint is applied for another 4 to 5 weeks. Rehabilitation of active range-of-motion exercise is initiated after removal of the splint. At 10 to 12 weeks postoperatively, gentle passive range-of-motion and strengthening exercises are started and gradually increased. The patient can resume regular activities 4 to 6 months after surgery. Strenuous sports or manual work should be carefully considered after 6 to 8 months postoperatively.

Discussion

In TFCC injury with DRUJ instability, the goal of the arthroscopic procedure is to reattach the deep component of the TFCC to the fovea of the ulnar head. This

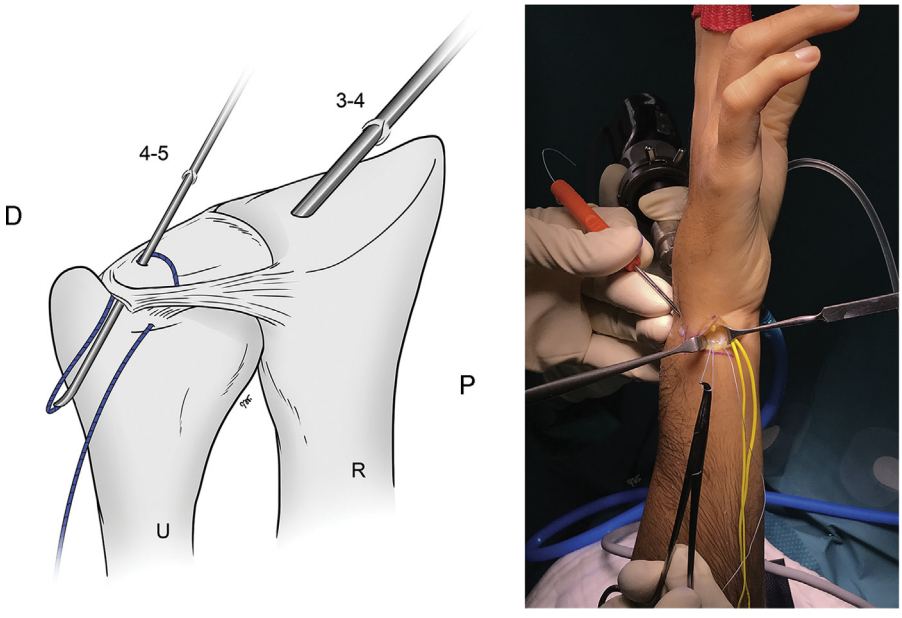

Fig 8. Illustration and intraoperative figures representing triangular fibrocartilage complex suture passing in a horizontal mattress, inside-out fashion from the palmar suture location to the dorsal suture location. Right wrist. (3-4, 3-4 portal; 4-5, 4-5 portal; D, dorsal; P, palmar; R, radius; U, ulna.)

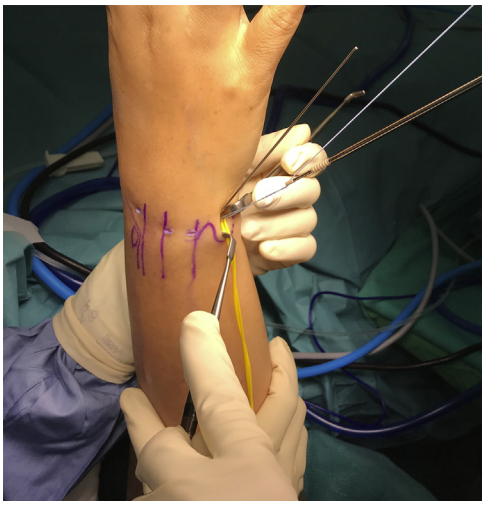

Fig 9. Two tails of the suture passing through the eyelet of a PushLock anchor preparing for insertion.

bony reattachment can be performed with either of 2 techniques: the transosseous technique or the suture anchor technique. Creating a precise tunnel for the transosseous technique requires exposure to the distal ulnar shaft and the ulnocarpal joint for passing of the K-wire and drilling. The process of K-wire passage and drilling with the use of fluoroscopy makes this procedure technically demanding. Another concern of this technique is the risk of TFCC injury while attempting passing of the K-wire or maintaining the targeting device over the TFCC disc during ulnar tunneling.[7,8,10,11] In contrast, reattachment using a suture anchor requires less dissection over the ulnar wrist, which may result in less tissue injury, especially on the TFCC disc.

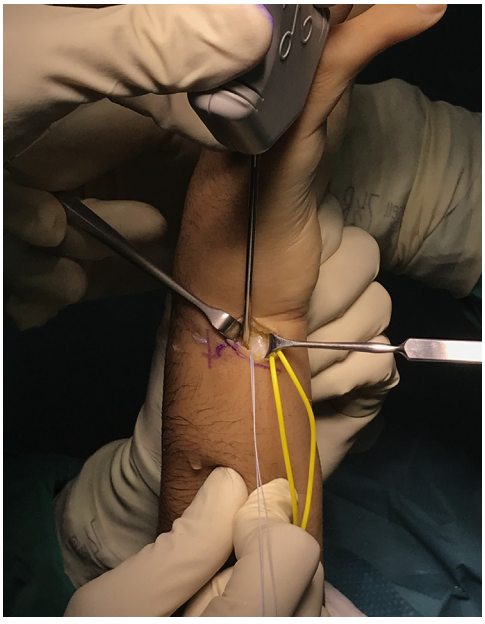

Fig 10. Insertion of the anchor while maintaining the distal radioulnar joint reduction in a neutral wrist position.

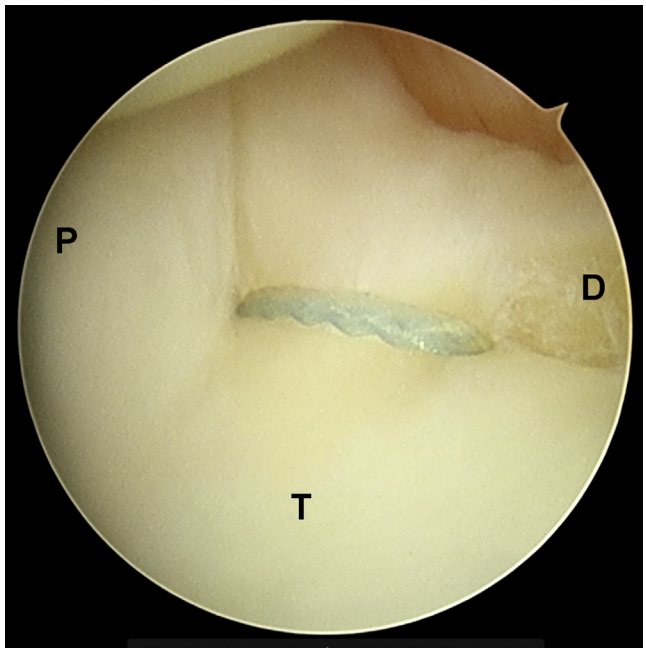

Fig 11. The secured foveal reattachment after anchor insertion. Right wrist; viewing portal 3-4. (D, dorsal; P, palmar; T, triangular fibrocartilage complex.).

The TFCC suture-passing technique for bony reattachment mostly has been proposed in an outside-in fashion. The risk associated with the outside-in technique also is increased because of multiple attempts to pass the TFCC suture from underneath TFCC disc in an effort to reach the proper location. Making a knot over the TFCC disc with the outside-in technique requires

Table 3. Advantages and Disadvantages

Advantages
1. Less exposure and less dissection over the distal ulnar and extensor carpi ulnaris tendon sheath for insertion of the suture anchor.
2. Less TFCC injury: no placement of the targeting device for ulnar tunneling as in the transosseous technique.
3. Less tissue injury: no need to approach the ulnocarpal joint via the 6U portal to secure the knot as in outside-in suture passing.
4. Less radiation exposure: no fluoroscopy needed as in the transosseous technique.
5. Less irritation: no knot at the bony cortex of the ulnar neck as in the transosseous technique.
6. Designation of the suture location and suture passing can be precisely performed in one attempt.
7. Passing the suture through the floppy TFCC is easier than in the outside-in technique.
Disadvantages
1. The dorsal sensory branch of the ulnar nerve still remains at risk of injury as in the outside-in technique.
2. The ulnar capsule and surrounding tissues may cover the fovea at the DF portal, which should be dissected clearly enough to insert the anchor.
3. The DRUJ reduction while inserting the anchor in the correct location requires good coordination with help from assistants.

DRUJ, distal radioulnar joint; TFCC, triangular fibrocartilage complex.

use of the ulnocarpal joint approach via the 6U portal area.

Few authors have proposed the inside-out technique for TFCC foveal repair. Fujio[6] recently reported the use of a guide for targeting the suture location. The author then drilled through the ulnar cortex to pass the suture and then expose the distal ulna to secure it. Tang et al.[12] used an inside-out TFCC suture through a meniscal double-barrel cannula in a limited number of 5 patients and a short follow-up of 8 months. This technique requires a large portal for passing the large cannula, which can injure the cartilage of the carpal bone. The fixed curve of the cannula may limit the direction of suture passing at the TFCC.

The technique used in our study required the standard 3-4, 4-5, 6R, and DRUJ portals with a mini-open approach to the DF portal to protect the ulnar nerve and insert the anchor. Insertion of the suture anchor required less dissection over the distal ulna than that required by the transosseous technique. Passing the suture using an inside-out technique allows grasping the TFCC to the foveal area without exposure of the extensor carpi ulnaris tendon sheath floor and ulnar styloid. Another advantage of the inside-out technique is the ability to easily locate and penetrate the floppy disc in patients with DRUJ instability.

The inside-out suture passing technique using the 4-5 portal while the arthroscope is in the 3-4 portal also has another advantage. Because the arthroscope is positioned on the radial side, passage of the suture using a suture lasso is not obstructed by the arthroscope, unlike passage of a fixed straight Tuohy needle from the 1-2 or 3-4 portal. Passing the suture through the 4-5 portal also can provide a wide angle for insertion of the suture device in contrast to the far and narrow angle from the 1-2 or 3-4 portal.

We use a limited approach to prepare the foveal surface underneath the disc via the DF portal.[5] Approaching the ulnocarpal joint via the 6U portal to secure the knot for outside-in suture passage or placing the targeting device for ulnar tunneling is not required. Thus, the innervation and proprioception at the joint capsule are preserved. Advantages and disadvantages are presented in Table 3.

Conclusions

The present technique of arthroscopic-assisted inside-out TFCC foveal reattachment is a less-invasive technique that involves minimal exposure and no creation of an osseous tunnel. This technique may be considered another effective option for the treatment of TFCC injury with DRUJ instability.

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