

Management of Type 1D Tears

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Anatomy of the TFCC

The so-called triangular fibrocartilage complex (TFCC) is an anatomical structure which is fundamental for the stability of the distal radioulnar joint (DRUJ). It is denominated “complex” as it is not a single anatomical structure, but various. The first author to define the term was Palmer in the year 1989 [1]. Since then, it has been understood that the TFCC is formed by an articular disk, the radioulnar ligaments (RUL) dorsal (DRUL) and volar (VRUL), the meniscus homologue, the ulnar collateral ligament, the ulnocarpal ligaments, and the tendon sheath of the extensor carpi ulnaris tendon (ECU) (Fig. 9.1).

The articular disk is a triangular meniscus-shaped structure. It is thinner in its central portion and widens out in the more dorsal and palmar part, where it becomes to dorsal and volar radioulnar ligaments. Histologically speaking, in the union with the radius there exists a reinforcement of short collagenous fibers, oriented radially, with an extension of 1–2 mm, while the fibers of the rest of the disk have a greater tendency toward intertwining and are less organized. The area of the union of the short fibers with the rest of the articular disk is where the type 1D tear commonly takes place [2].

The radioulnar ligaments stabilize the DRUJ joint. Ishii, in his anatomical study [3], shows how they have both a superficial and deep layer. The deep portion, called sub-cruentum ligament, is inserted in the fovea of the ulna, whereas the superficial part envelops the articular disk and becomes united to it in the more ulnar part. Nowadays it is known that the deeper part has greater importance in maintaining the stability of the distal radioulnar joint [4, 5].

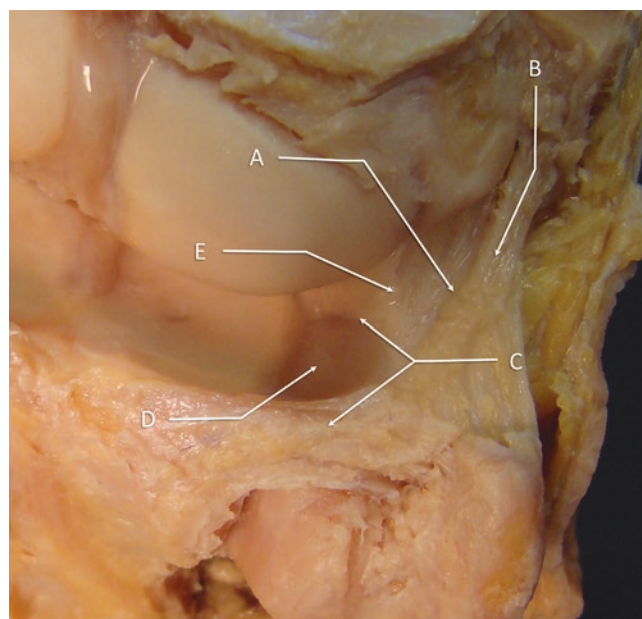


Fig. 9.1 (A) Meniscus homologue. (B) Ulnar collateral ligament. (C) Radioulnar ligaments. (D) Articular disk. (E) Ulnocarpal ligaments

The so-called meniscus homologue refers to the tissue, which is to be found between the superficial insertion of the radioulnar ligaments and the articular capsule [3]. In a certain anatomical study, it has been postulated that it consists of the remains of a large apophysis of the ulnar styloid which, in primates, is joined to the pisiform and pyramidal [6].

The ulnar collateral ligament is a thick structure, which is inserted proximally into the base of the ulnar styloid and distally in the pisiform and triquetrum. It is in close contact with the ECU and distally its fibers converge with the meniscus homologue [7].

The last structure that forms the TFCC is the tendon sheath of the ECU. It is connected to the head of the ulna and the ulnar fovea by means of Sharpey fibers.

From a didactic viewpoint, the TFCC has been compared to a tridimensional structure with two walls and a floor. The

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floor of this structure would be the articular disk and the volar and dorsal radioulnar ligaments; the palmar wall would be formed by the ulnocarpal ligaments; and the dorsal wall would be formed by the tendon sheath of the ECU.

The integrity of the TFCC is fundamental for two functions. The first of these maintains the stability of the distal radioulnar joint that, as has already been commented, is carried out fundamentally by the radioulnar ligament [4, 5, 8]. The second function refers to the correct transmission of the load. It is known that approximately 20% of the wrist load is transferred through its ulnar border, that is to say, through the TFCC, so that any lesion may alter it [1].

Vascularization of the TFCC

The ulnar artery is that which gives greater blood supply to the TFCC, above all in its ulnar portion. The more radial part is irrigated by means of volar and dorsal branches of the anterior interosseous artery.

In histological studies, such as those carried out by Bednar [9] and Thiru [10], it has been seen that the blood vessels penetrate the TFCC from the periphery and can be observed only in an external 10–40% of their size. These vessels may be observed above all in the dorsal, ulnar, and palmar area of the TFCC. Thus, the “radial and central portion” is relatively avascular, unlike the volar radial and dorsal radial, that is to say, the radioulnar ligaments.

It has been considered that the central area, as it has lesser vascular supply, it lacks a healing capacity. But Cooney [11] in a series of 23 patients with peripheral tears of the radial margin treated by open surgery obtained good or excellent results in 80% of the cases. By the same token, he verified that 2 years after surgery, there still existed continuity of the reparation in four out of five patients.

That is, the fact that in histological studies the central area of the radial portion of the TFCC should not have a large number of vessels does not mean that the radioulnar ligaments do not have them and neither does it mean that the healing may not be obtained after a correct bone bed preparation for the anchoring. In the same way that a meniscal lesion of the knee is not sutured in the white–white area, in the TFCC, healing is not attained by suturing a tear of the most central part (1A lesion), but the healing can be attained of the “central radial” portion with the radius (this would be a red–white area) or of the radioulnar ligaments with the radius (it would be a red–red area).

Diagnosis

Physical Examination

Patients with a radial lesion usually recall a traumatic precedent, above all in a fall with the wrist in hyperextension and ulnar deviation or also a sharp twist of the wrist.

The patient complains of pain and swelling in the ulnar area of the wrist and discomfort with the movements of ulnar deviation and pronosupination. If the lesion is a significant one and involves radioulnar instability, the dorsal prominence of the ulna may be observed, but it should always be compared with the contralateral wrist in order not to confuse it with a hypermobile wrist.

There exist several exploration tests of the TFCC, but in our view, the most useful ones are the three following ones (Fig. 9.2).

Ulnar fovea sign [12]: With the elbow of the patient in a state of flexion, the thumb palpates the depression formed by the flexor carpi ulnaris, the ulnar styloid, the head of the ulna, and the pisiform. It may be regarded as positive when pain appears compared with the contralateral. It is one of the most

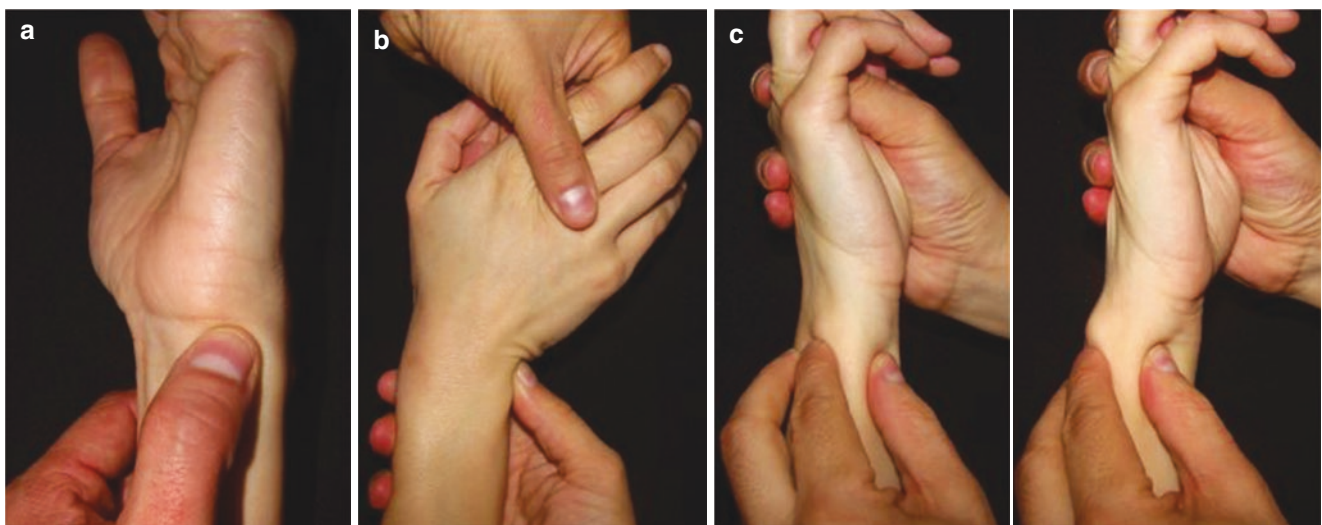


Fig. 9.2 (a) Ulnar fovea sign. (b) Ulnocarpal stress test. (c) Radioulnar instability exploration

important signs in this kind of pathology, as it has a very high sensitivity and specificity (95% and 87%, respectively).

Ulnocarpal stress test [13]: is carried out by the application of axial loading to the wrist in a state of maximal ulnar deviation while a movement of pronation and supination is applied. It is a very sensitive sign but not a very specific one as it can be positive in a number of pathologies that affect the ulnar region of the wrist.

Radioulnar instability [5]: In order to evaluate the stability of the distal radioulnar joint, the ulna is displaced with respect to the radius in an anteroposterior plane with the wrist in a neutral position, in supination and pronation. These maneuvers should be carried out in both the affected side and the contralateral one, because instability should not be confused with articular laxness.

Diagnostic Modalities

Tears in the TFCC are not detected by simple radiographic examination, but they can reveal indirect data, which may indicate the possibility of a lesion. Thus, lateral and oblique and AP projections are useful to diagnose the presence of fractures-avulsions of the sigmoid notch and DRUJ instability as, with a complete radial desinsertion, the space of this joint will increase.

Tricompartamental arthrography has been the standard method used for the diagnosis of lesions of the intra-articular ligaments of the wrist [14]. It consists of a contrast injection under radiological control in the radiocarpal joint, midcarpal, and DRUJ. In the presence of a radial tear, there appears an extravasation of the contrast.

With the development of new technical advances in magnetic resonance imaging (MRI), improvement has been

achieved in the resolution and diagnosis of TFCC lesions; the former being the preferential technique of several authors [15, 16]. Arthro-MRI may add further information to the study and is shown to be superior to the standard MRI for the detection of complete tears of the TFCC [17].

The carrying out of helical computerized axial tomography (CT) together with arthrography combines the advantages of both techniques; the intra-articular structures and compartments remain distinctly defined in multiple planes. Thanks to this, the location of the tear may be determined with greater precision [18] and may be regarded as an alternative technique to that of arthro-MRI [19].

But without any shade of doubt, the “gold standard” in the diagnosis of 1D-type lesions of the TFCC is still arthroscopy of the wrist, as it allows a direct visualization of the tear, determines the location and lesion type, and detects other associated lesions.

Classification

In 1989, Palmer classified TFCC lesions into two large groups [1]. The first of these included traumatic lesions and he denominated them class 1, and the degenerative lesions class 2. Likewise, the traumatic lesions are subdivided according to their location, a central slit as 1A, ulnar tear as 1B, distal tear as 1C, and radial tear as 1D.

Radial tears are avulsions of the TFCC from the radial sigmoid notch and may or may not include bone fragments.

Although controversy exists as to what a 1D tear is and what it is not, one of the best classifications which define them is that of Nakamura [20] who subdivided the radial lesions of the TFCC into six groups (Fig. 9.3).

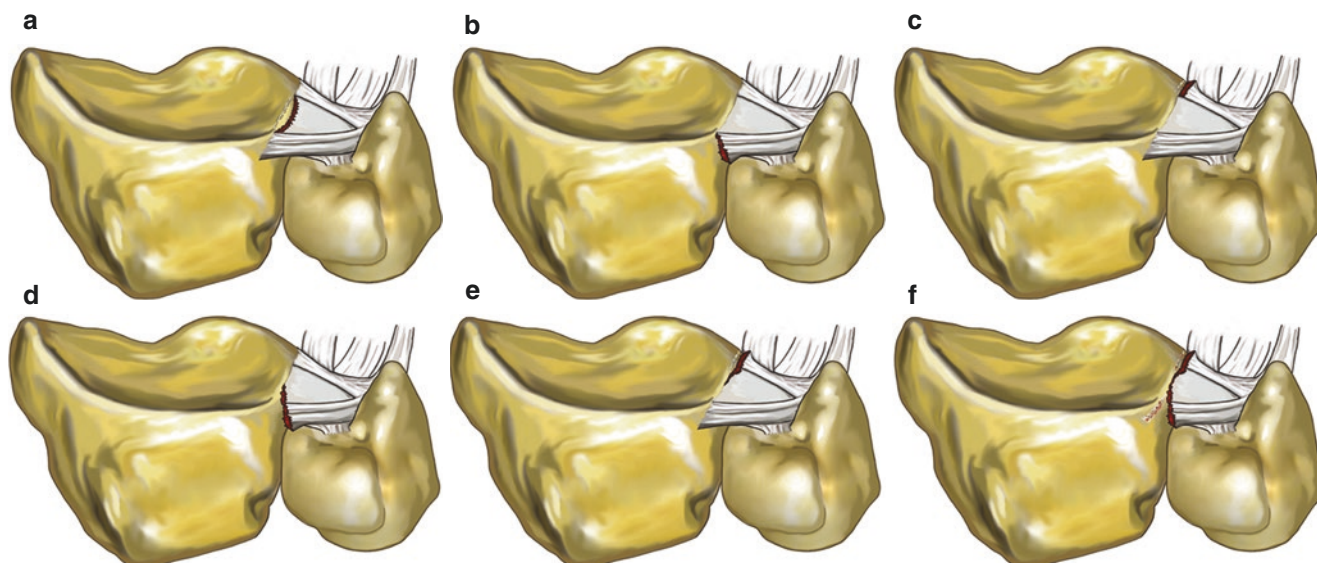


Fig. 9.3 (a) Fibrocartilage tear between the hyaline cartilage of the sigmoid notch of the radius and TFCC. (b) Dorsal edge tear between the dorsal notch of the sigmoid notch of the radius and dorsal portion of the radioulnar ligament. (c) Palmar edge tear between the palmar edge of the sigmoid notch of the radius and palmar portion of the radioulnar ligament. (d) Combination of (a) + (b). (e) Combination of (a) + (c). (f) Complete detachment of the TFCC from the sigmoid notch of the radius

of the sigmoid notch of the radius and palmar portion of the radioulnar ligament. (d) Combination of (a) + (b). (e) Combination of (a) + (c). (f) Complete detachment of the TFCC from the sigmoid notch of the radius

- (a) Fibrocartilage tear between the hyaline cartilage of the sigmoid notch of the radius and TFCC
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- (d) Combination of (a) + (b)
- (e) Combination of (a) + (c)
- (f) Complete detachment of the TFCC from the sigmoid notch of the radius

As has already been seen, the stability of the DRUJ depends on the integrity of the radioulnar ligaments, and thus a type 1D-a may not be associated with DRUJ instability, whereas a type 1D-b–f can induce DRUJ instability.

Further doubt may exist with regard to differentiating a 1D-a lesion (radial lesion) from a 1A lesion (central lesion), as the only difference is a few millimeters of fibrocartilage tissue. In our view, the most important thing is to determine the treatment to be carried out rather than an evaluation as to whether a fibrocartilage tissue exists or not between the tear and the radius.

We would advocate a debridement of the portion of the fibrocartilage united to the radius and an evaluation as to whether the articular disk can be approximated to the radius without tension. If this is the case, the reattaching of the lesion would be carried out and we would denominate it 1D-a. If the disk cannot be approximated without tension, only the debridement would be carried out and the lesion would be classified as 1A (Fig. 9.4).

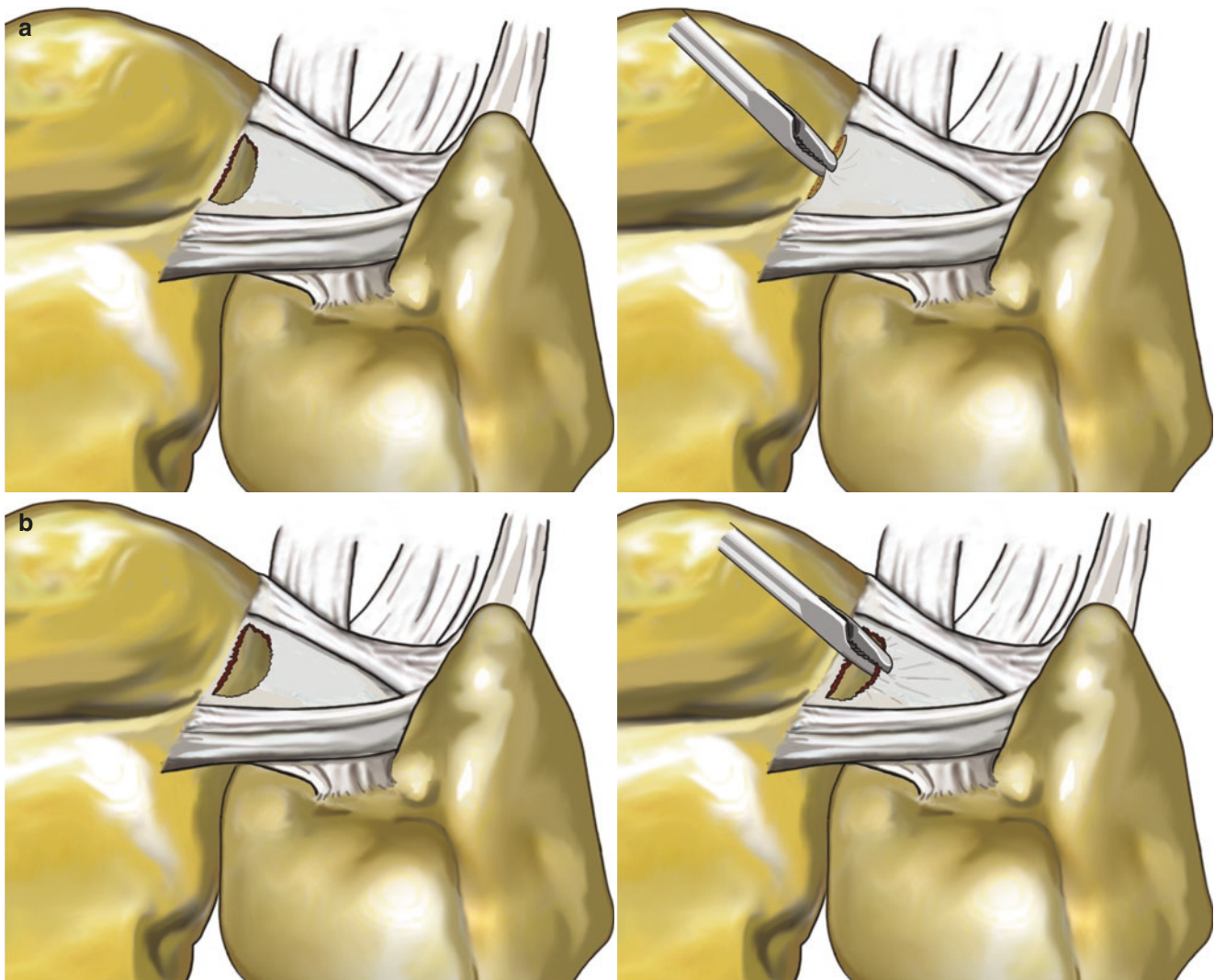


Fig. 9.4 (a) After the debridement the articular disk can be approximated without tension to the radius sigmoid notch. We would classify the lesion as 1D-a and the reattachment back down to the bone could be

made. (b) After the debridement the articular disk cannot majorly be approximated without tension to the radius sigmoid notch. We would classify the lesion as 1A and only a debridement would be carried out

Treatment

Conservative Treatment

Treatment in the acute phase of lesions of the TFCC, not associated with clinical instability, includes immobilization for 3–4 weeks, nonsteroid anti-inflammatories, steroid injections, and physiotherapy.

Indication of Surgical Treatment

Both the failure of a conservative treatment, without improvement after 3 months, and the existence of associated distal radioulnar instability indicate the need for surgical treatment.

Surgical Treatment

Many classical papers advocate the treatment of most of the lesions of the TFCC by means of debridement or excision [21, 22]. This practice has been supported by a study, which concludes that the resectioning of at least two thirds of the articular disk does not influence in the DRUJ biomechanics [23]. However, in this study the peripheral margins of the TFCC were respected, that is to say, the radioulnar ligaments. More recent studies have highlighted the importance of the integrity of these ligaments in order to maintain DRUJ stability [4, 5]. This has increased the interest of many authors to repair the TFCC instead of a debridement.

In the case of radial side tears, there exists greater agreement on carrying out a repair when the radioulnar ligaments are affected. As we have seen supra, these ligaments are vascularized structures with potential healing. Greater doubt exists with regard to the repair of a central radial tear without affecting the radioulnar ligaments, but, as we have already mentioned, our view is that, if after the debridement the articular disk can be approximated without tension, we would advocate its repair back to the bone. With this reparation we believe that there may be avoided a possible progression toward the radioulnar ligaments.

One of the first open techniques described for the repair of the radial edge of the TFCC was described in 1994 by Clooney [11] who obtained good or excellent results in 80% of his patients. Since that time numerous arthroscopic techniques have been described:

Trumble [24, 25] used a meniscal suture system with two preloaded needles; the suture was knotted on the radial side of the radius. He obtained improvement in the range of motion up to 89% and grip strength up to 95% with respect to the contralateral side.

Sagerman and Short [26] described a similar technique, whose difference was based on the carrying out of three bone tunnels through which there passed the meniscal suture systems. The results were good or excellent in 8 out of 12 patients.

Plancher [27] described a technique in which a suture was also carried out by passing it through the radius. With the usage of an external guide, he managed to make two tunnels in the radius with a single outward opening in the sigmoid notch. A suture passer was used in an outside-inside way, and the threads were knotted on the radial side of the radius.

Fellinger [28] described the repair of tears of the radial side using the T-Fix Device® (Acufix). A single bone tunnel was made through which this system was passed in an outside-to-inside manner. Once the TFCC had been traversed, the “T” form anchorage was established, maintaining united the TFCC to its insertion zone.

Jantea [29] also used an external guide to create the tunnels. In one of them a spinal needle loaded with an absorbable monofilament was passed and in the other a suture retriever. The sutures were knotted on the dorsal side of the radius. Good results were obtained in 11 out of 12 patients.

Geissler [30] developed a new anchorage system with technology similar to the system of meniscal suture RAPIDLOC® (De Puy Mitek). Through two bone tunnels the system is introduced, the fibrocartilage is perforated, and the topHat is extended. It slides toward the radial region of the radius where the TFCC remains fixed.

All of these techniques require the use of bone tunnels which pierce the radius and through which the sutures are passed. With the development of new implants and instruments nowadays, the reattachment can be carried out arthroscopically without the necessity of carrying out bone tunnels or knots. The following explains the technique of making it.

Arthroscopic Knotless Radial-Side TFCC Repair

The portals that this technique requires are the dorsal 3/4, 6R, and 4/5 radiocarpal portals. The wrist is placed in the traction tower, applying 10 lb of traction. Firstly the 3/4 radiocarpal portal is performed, it is marked with an 18-gauge needle, the tip of a number 11 scalpel is introduced, and the portal is widened with a blunt dissector. Through this portal the arthroscope is introduced, the whole of the radiocarpal joint is inspected, and the TFCC is visualized.

The second portal that should be made is the 6R. As well as in the case of the 3/4 portal, an 18-gauge needle is introduced; on this occasion it is verified under arthroscopic control that it is located just above the TFCC, afterward the tip of the scalpel is introduced, and finally the portal is widened with a blunt dissector. By carrying out the portal under direct

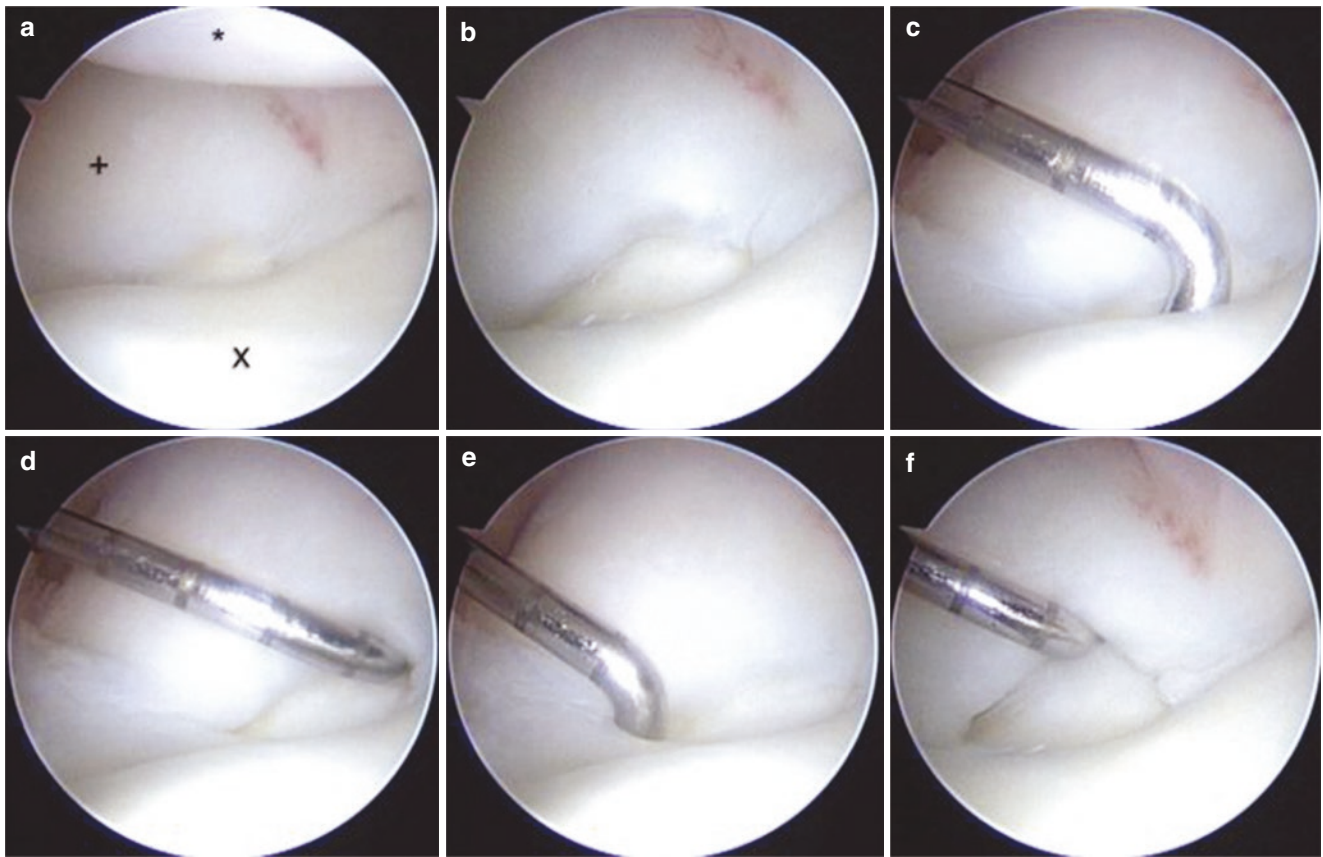


Fig. 9.5 (a) Ulnar compartment seen from the 3/4 portal (*Lunate, +TFCC, XRadius). (b) Radial lesion of the TFCC. (c) Probe in the sigmoid notch. (d) The tear extends to the volar radioulnar ligament. (e)

Integrity of the dorsal radioulnar ligament. (f) The ulnar head is seen under the radial lesion of the TFCC

visualization, it is not probable to cause lesion of the TFCC or the articular cartilage.

The probe is inserted through the 6-R portal, and the location and extension of the radial tear in the TFCC is evaluated. In order to be able to classify this type of lesion correctly, particular attention should be paid to its dorsal or palmar extension, that is to say, the injury of the dorsal and palmar radioulnar ligaments (Fig. 9.5).

If the lesion extends to the radioulnar ligaments, or if it is a central tear but as has already been commented, approximation to the sigmoid notch can be made without tension, the repair of the TFCC back down to the bone can be performed as follows.

In the same way as the reattached of a peripheral ulnar tear [31], this technique requires one visualization portal (the 3/4 portal) and two working portals. Instead of carrying out a 6R accessory portal as it is made in an ulnar tear, a 4/5 portal is performed. Given the radial location of the lesion, this portal will greatly facilitate the technique. The 4/5 portal may be made also under arthroscopic control, first it is located with an 18-gauge needle (Fig. 9.6), afterward incised with the scalpel, and finally dilation is made. In a cadaver study published by the authors of this chapter [32], it has been found that while performing the 4/5 portal, an injury of

the fifth extensor tendon could happen, and thus special care should be taken with it.

The TFCC SutureLasso 70° (Arthrex, Naples, FL, USA) is introduced through the 6R portal. Its tip is situated just above the articular disk, penetrating from distally to proximally, coming out just below the tear. In order to penetrate easily the TFCC, a probe may be used to make counterpressure from the inferior side. The whole thickness of the TFCC is pierced through, and it can be verified how the tip of the SutureLasso appears between the inferior side of the disk and the ulnar head (Fig. 9.7).

The SutureLasso is loaded with a Fiber-Stick Suture® (Arthrex, Naples, FL, USA), which is a 2/0 Fiberwire suture with a more rigid end which facilitates its insertion in the passer. It is recovered with a Mini Suture Hook® (Naples, FL, USA) or a grasper through the 4/5 portal (Fig. 9.8).

Following this, the SutureLasso is withdrawn and, without removing it from the radiocarpal joint, it is reinserted a few millimeters from the first point and in the same distal and to proximal direction until it comes out below the TFCC. As the SutureLasso is still loaded with the Fiber-Stick, the suture is retrieved again through the 4/5 portal, and thus the horizontal mattress-type suture is complete (Fig. 9.9).

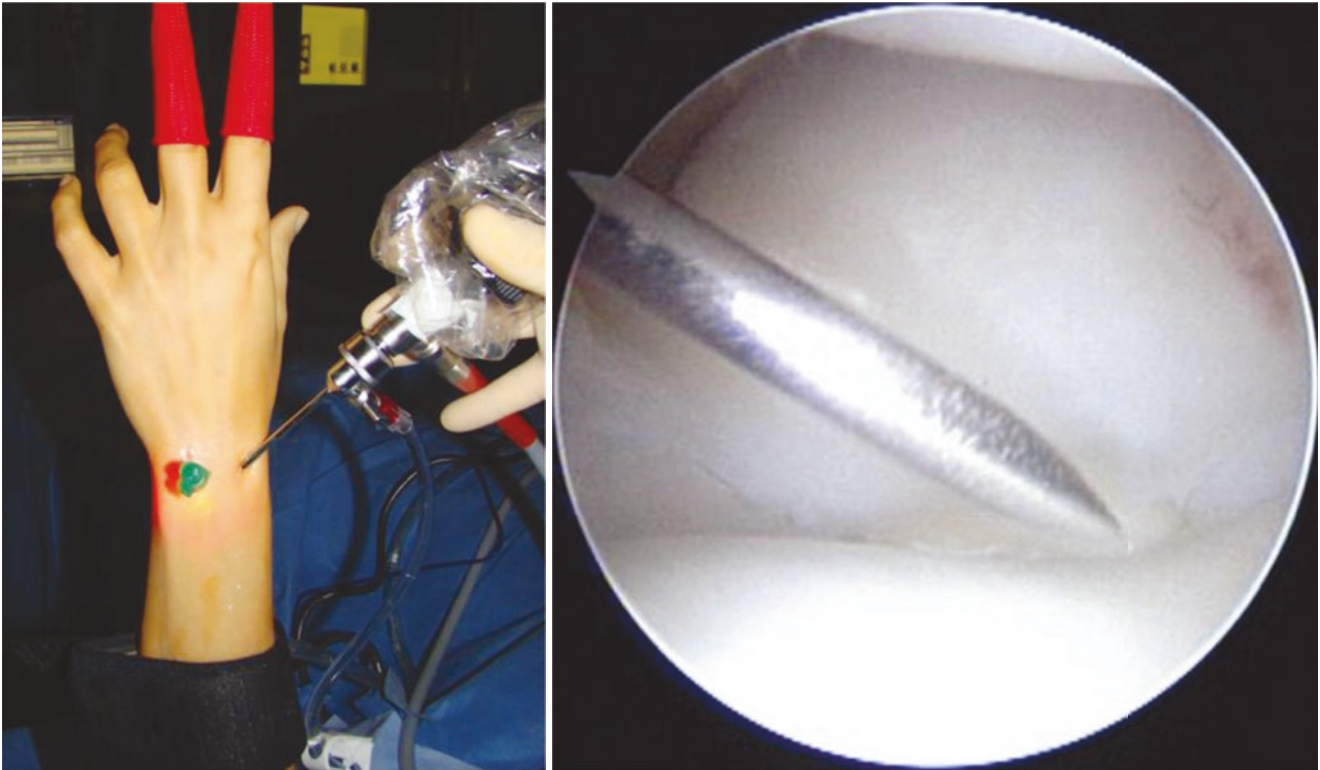


Fig. 9.6 Establishment of the working accessory portal; in this technique it would be the 4/5 portal

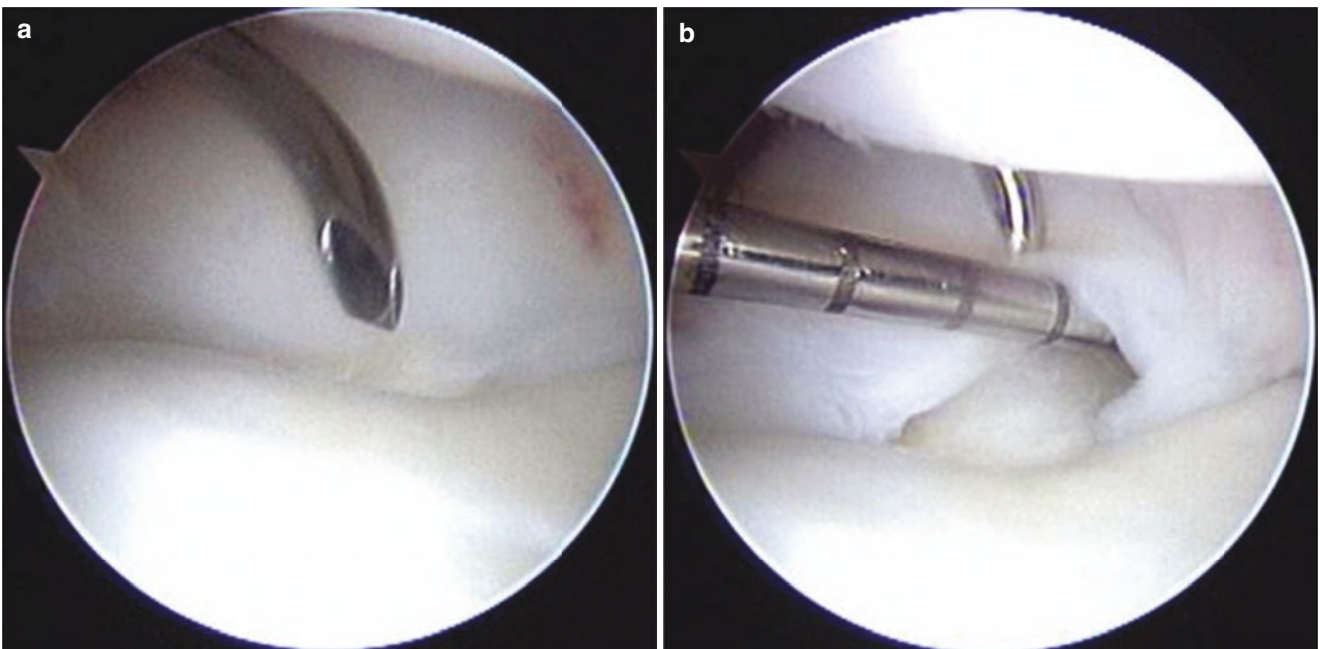


Fig. 9.7 (a) The TFCC SutureLasso 70° (Arthrex, Naples, FL, USA) is introduced through the 6R portal. (b, c) With the help of the probe, the whole thickness of the TFCC is pierced through. (d) The tip of the SutureLasso appears between the inferior side of the TFCC and the ulnar head

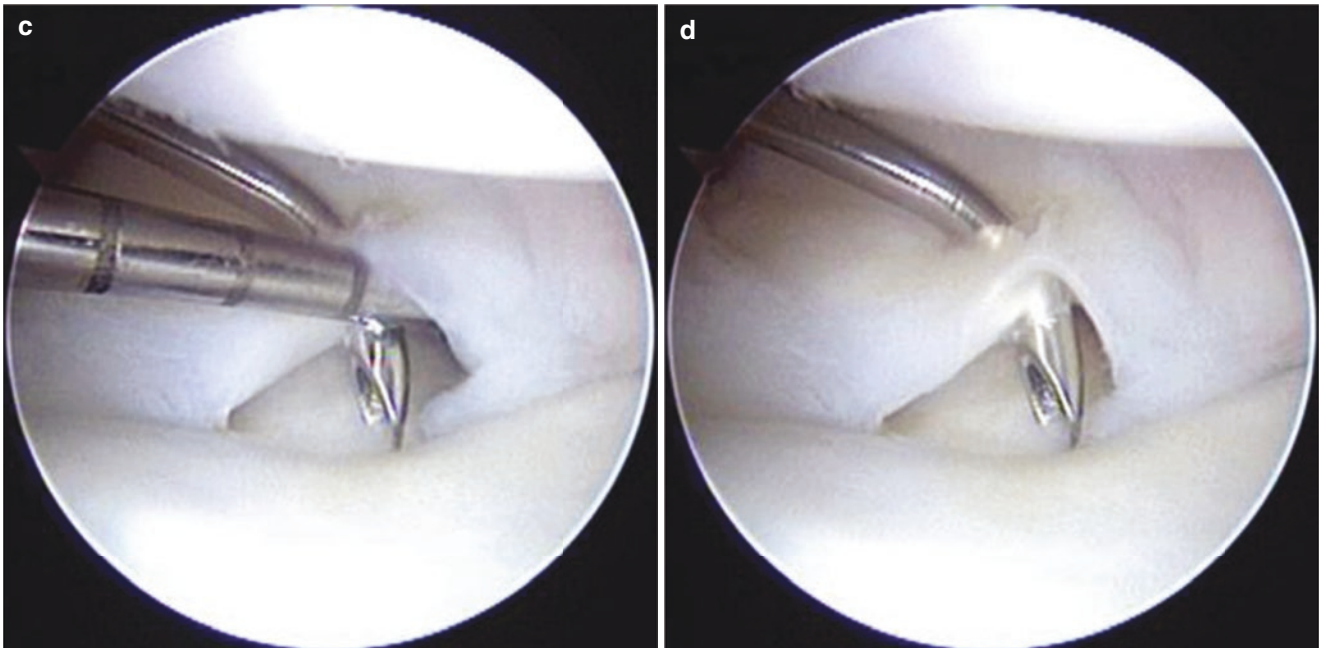


Fig. 9.7 (continued)

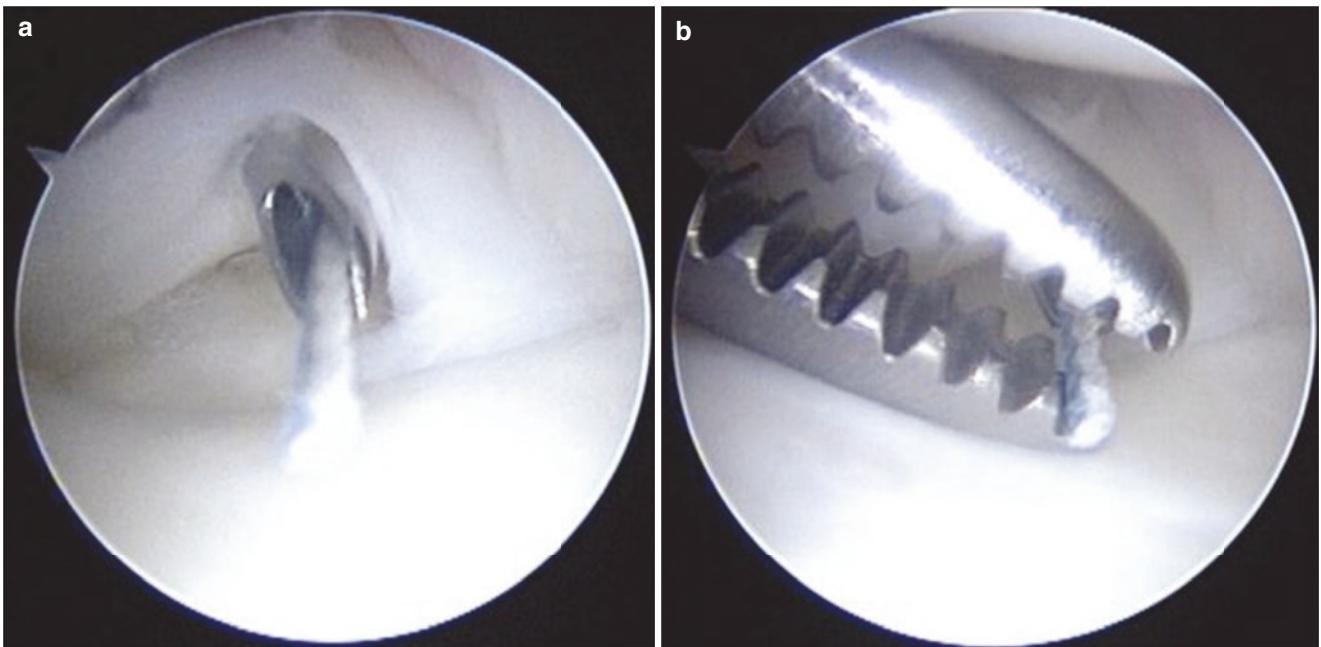


Fig. 9.8 (a) The SutureLasso is loaded with a Fiber-Stick suture (Arthrex, Naples, FL, USA). (b–d) It is retrieved to the 4/5 portal

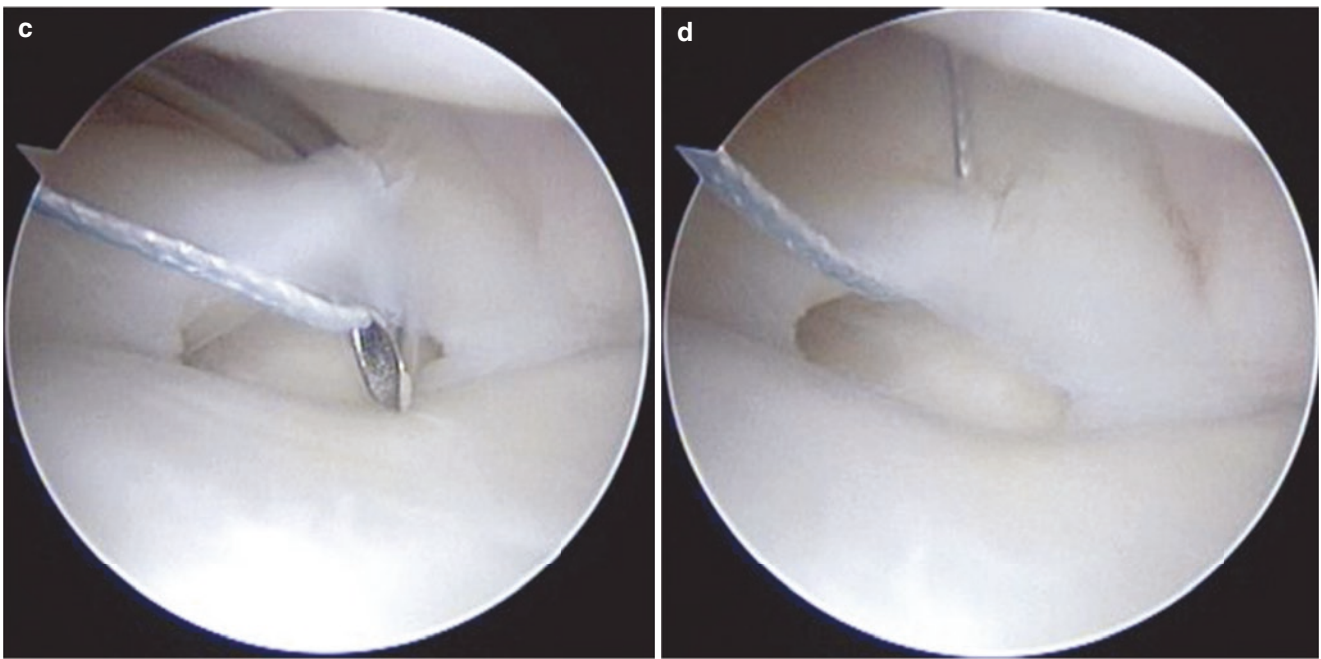


Fig. 9.8 (continued)

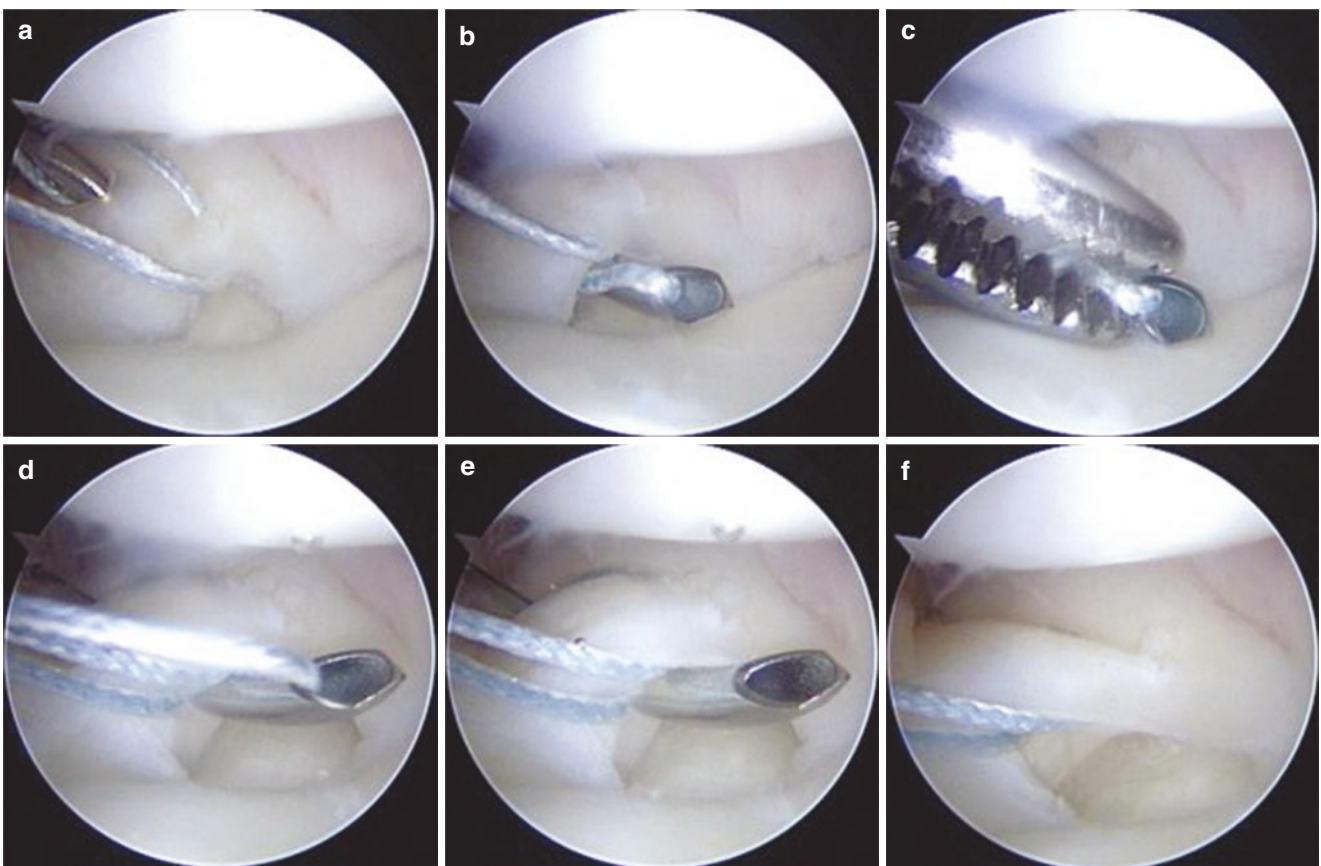


Fig. 9.9 (a) The SutureLasso is reinserted a few millimeters from the first point and in the same distal and to proximal direction. (b) It comes out again below the TFCC. (c–e) The Fiber-Stick suture is retrieved

again to the 4/5 portal. (f) In this way, the horizontal mattress-type suture is complete, with the sutures coming out through the 4/5 portal

The SutureLasso is withdrawn, and the slotted cannula together with the obturator of the TFCC instrument Kit[®] (Arthrex, Naples, FL, USA) is inserted through the 6R portal, the obturator is withdrawn from the cannula, and the Mini Suture Hook is inserted to retrieve the two sutures from the 4/5 portal to the 6R portal (Fig. 9.10).

The threads are passed outside of the cannula through the slot in order that the drilling afterward should not break them. The obturator is then inserted into the cannula and is placed at the desire point of reattachment in the sigmoid notch of the radius. Through the obturator the guidewire of the kit is inserted into the radius. At this point it is useful to

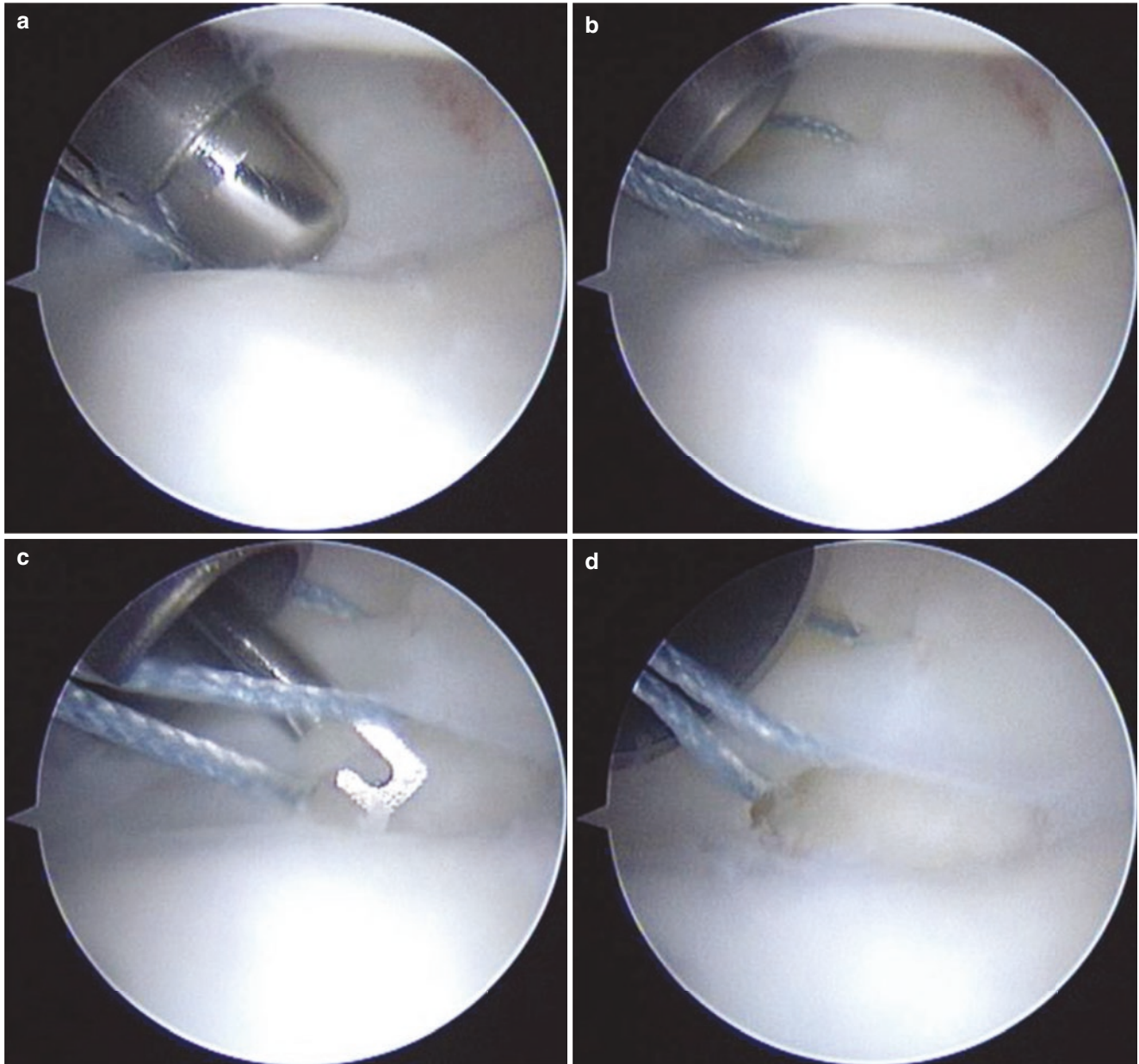


Fig. 9.10 (a) The slotted cannula together with the obturator of the TFCC instrument Kit (Arthrex, Naples, FL, USA) is inserted through the 6R portal. (b) The obturator is withdrawn from the cannula. (c) The

Mini Suture Hook is inserted to recover the two sutures from the 4/5 portal to the 6R portal. (d) The two wires are retrieved from the cannula through the slot

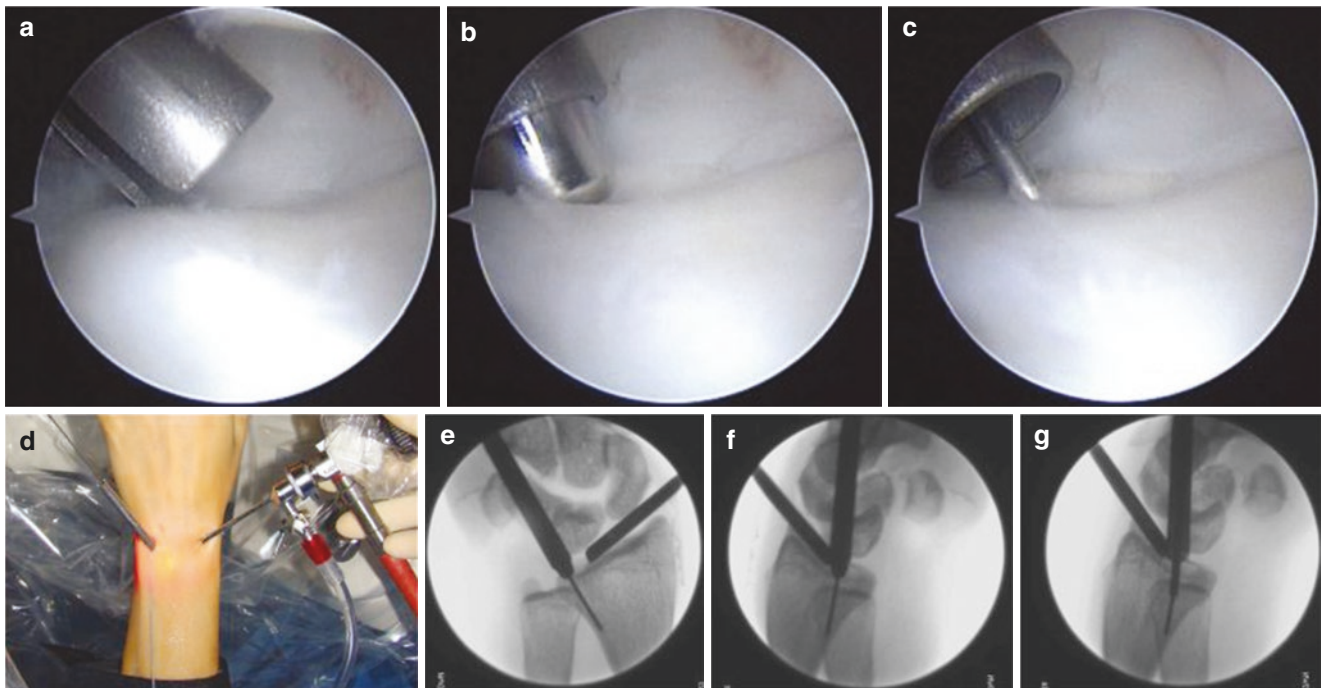


Fig. 9.11 (a–d) The Kirschner guidewire is placed through the obturator and inserted into the radius. (e–g) Fluoroscopy control to check the correct position of the guidewire and the drill

check under fluoroscopy in order to ascertain that the position is correct. The obturator is removed and the cannulated drill bit from the TFCC kit can be placed over the guidewire and drilled until the positive stop of the drill meets the cannula (Fig. 9.11).

On retrieving the cannulated drill and the guidewire, it is of paramount importance that the surgeon should maintain the cannula in the same direction in order not to lose the location of the tunnel. In order to do this, it is useful for one surgeon to hold only the arthroscope and the cannula and for the other one to carry out the fixation with a 2.5-mm PushLock Anchor® (Arthrex, Naples, FL, USA). The PushLock tip is positioned in the predrilled hole, and the suture tails can be tensioned by pulling on the suture and holding the PushLock anchor in place. The laser line of the PushLock should be advanced until flush with the bone, locking the anchor and suture in the predrilled hole (Fig. 9.12).

The sutures are cut and the tension is verified again (Fig. 9.13).

Conclusion

Two factors have conditioned the fact that many surgeons advocate the debridement of the radial lesions of the TFCC. The first one is considering the radial side of the TFCC as an avascular zone and the second one is the fact that the arthroscopic fixation techniques were very complex.

Nowadays, we know that the more dorsal and volar portion of the TFCC, that is to say, the radioulnar ligaments, are essential for maintaining adequate radioulnar stability. It is also known that these ligaments have an adequate blood supply, which allows its healing. For such motives, its repair back to bone is indicated. We also know that the more central and avascular portion can heal if a correct cruentation of the radius is performed and forms an adequate bed for the reattaching. For these reasons, we advocate the reinsertion of radial lesions (including the central ones) always provided that a correct tension can be attained.

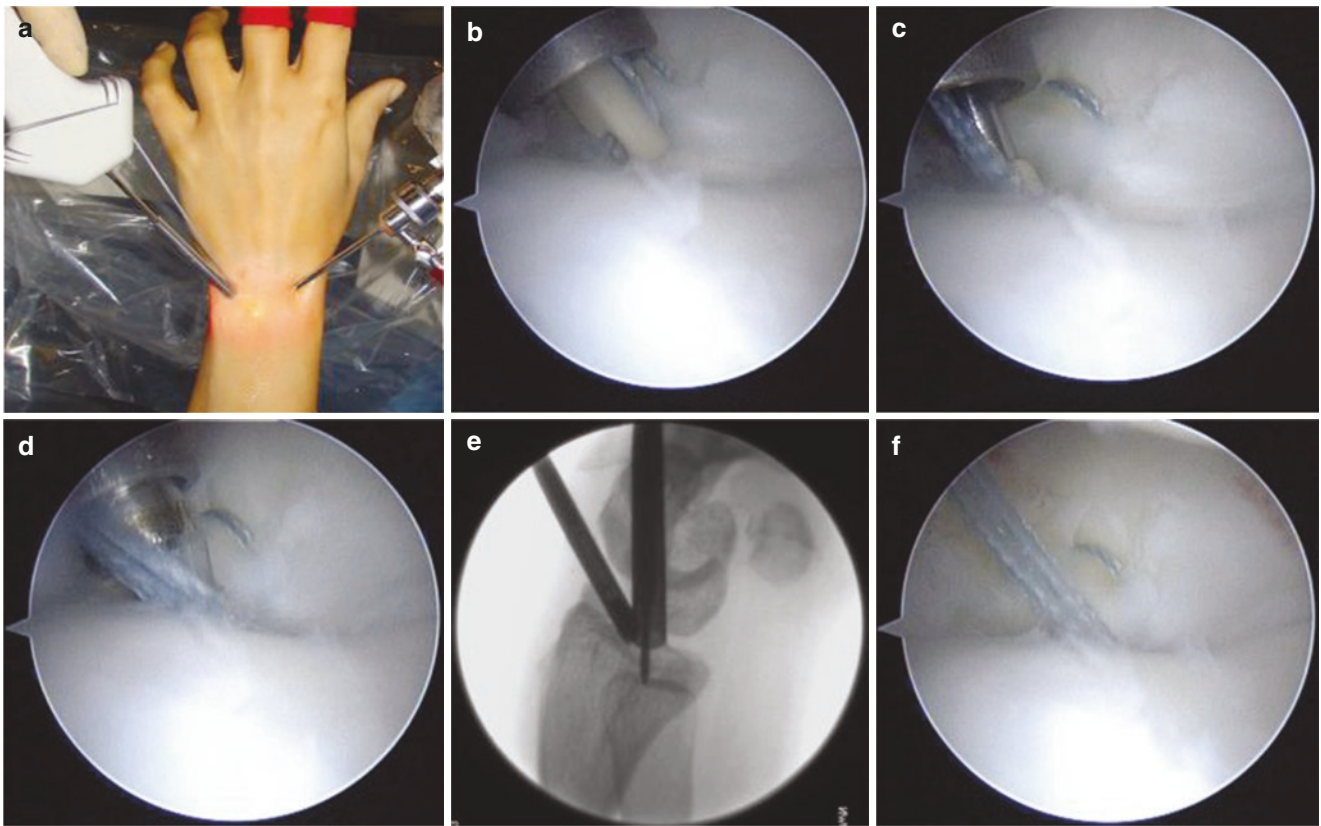


Fig. 9.12 (a) The 2.5-mm PushLock Anchor (Arthrex, Naples, FL, USA) and sutures are fed into the slotted cannula. (b–d) The 2.5-mm PushLock Anchor is introduced into the predrill hole in the sigmoid

notch. (e) Fluoroscopy control. (f) The radial peripheral tear is repaired back to bone. The suture tails can now be cut flush with the disk

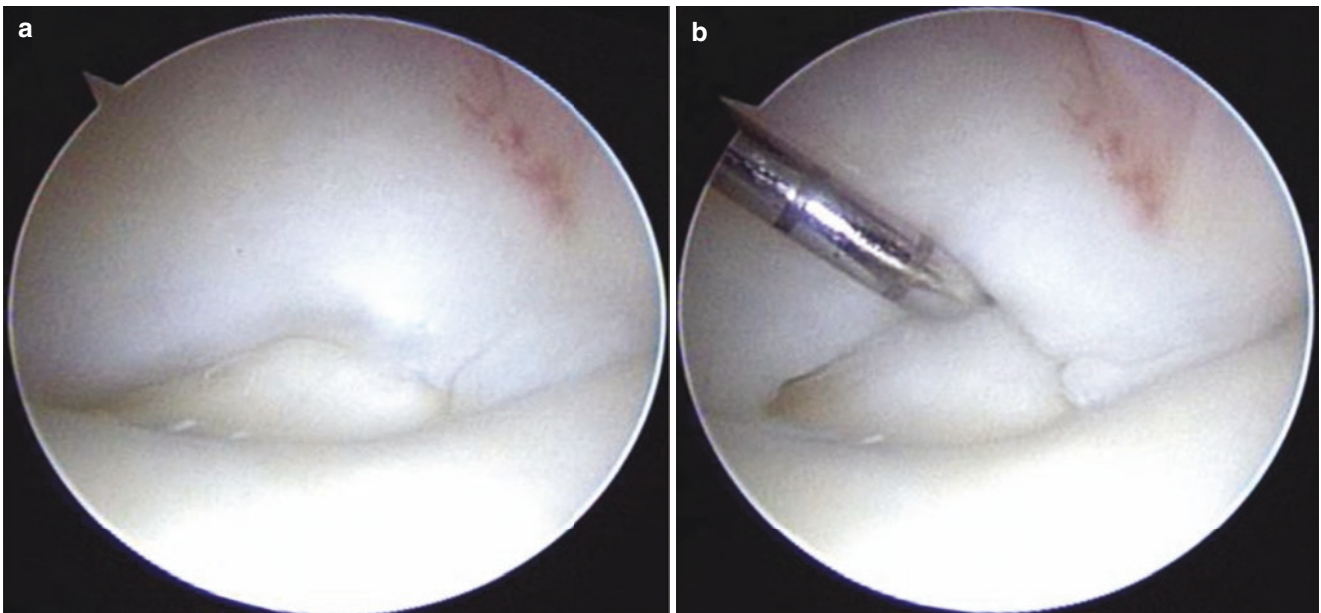


Fig. 9.13 (a, b) Initial aspect of the radial tear. (c, d) TFCC reattached to the sigmoid notch

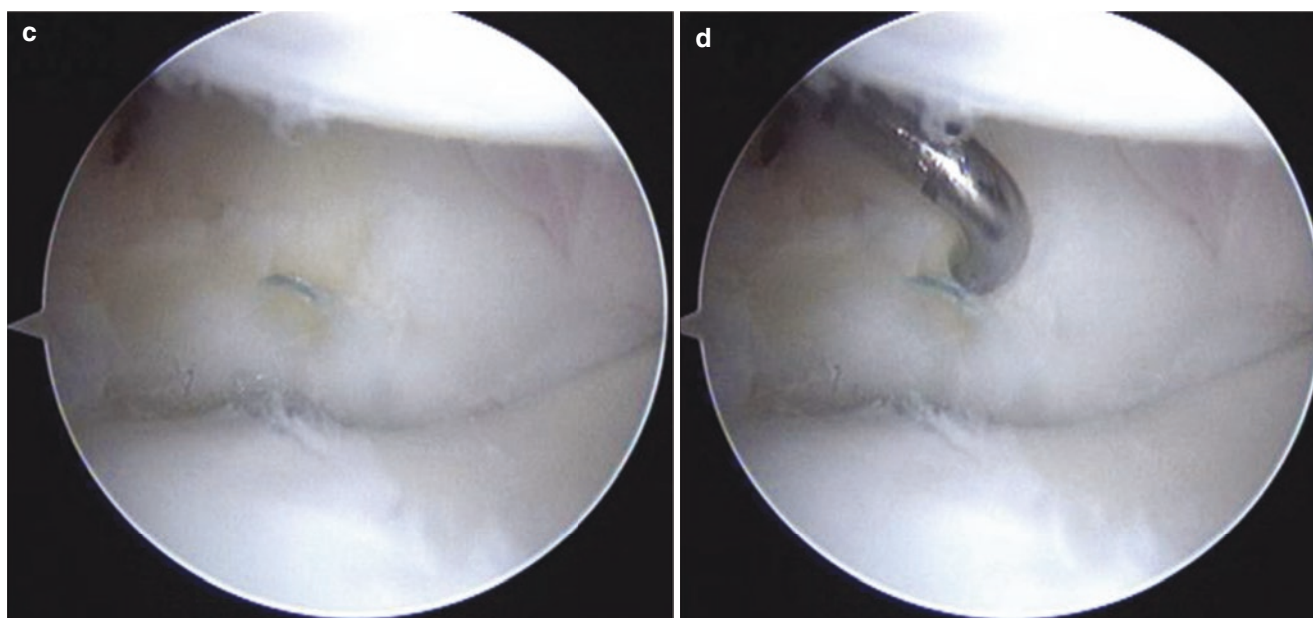


Fig. 9.13 (continued)

Advances in the development of surgical instruments have resulted in the technique for the reattaching of radial lesions presented in this chapter being simple to carry out through the 6R and 4/5 portals without the need of knots or bone tunnels through the radius.

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