Eur J Trauma Emerg Surg (2016) 42:29–35
DOI 10.1007/s00068-015-0593-x

REVIEW ARTICLE

Arthroscopic treatment for ulnar-sided TFCC-tears

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Received: 17 August 2015 / Accepted: 23 October 2015 / Published online: 13 November 2015

Abstract
Objective Ruptures of ulnar-sided triangular fibrocartilaginous complex (TFCC) often occur in cases of trauma. Golden standard for diagnosis is the arthroscopy of the wrist. TFCC lesions are classified according to their location if traumatic in origin or if degenerative according to their severity.
Materials and methods Recent literature has focused on the ruptures of ulnar-sided triangular fibrocartilaginous complex. This article describes conservative, operative and arthroscopic surgical techniques to reconstruct the triangular fibrocartilaginous complex and restore distal radioulnar joint stability.
Results The main therapeutic goal should be the stabilization of the DRUJ by reattachment of the torn ligaments in ulnar-sided ruptures to the deep fibers in the fovea. This reinsertion can be performed by transosseous suture, a suture anchor or open.
Conclusion Central TFCC tears are typically located close to the sigmoid notch of the radius and are either traumatic or degenerative in origin. While central TFCC lesions are usually treated by arthroscopic debridement using small joint punches or a bipolar high frequency system, the ulnar TFCC avulsions can also be refixed arthroscopically in different techniques.

Keywords TFCC lesions · Arthroscopy of the wrist · Wrist pain

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Introduction

From the early beginning, wrist arthroscopy, diagnosis and treatment of diseases of the ulnar part of the wrist and distal radioulnar joint (DRUJ) played an important role. The function and stability of the DRUJ depend on joint surfaces and, in particular, the degree of the dynamic and static, stabilizing soft tissues.

The central structure to stabilize the DRUJ and the connection to the proximal wrist is the triangular fibrocartilaginous complex fiber (TFCC) (Figs. 1, 2). In the triangular fibrocartilage, the ulnocarpal and ulnoradial ligaments are interwoven. This may be damaged traumatically, but is often also subject to significant degenerative processes. Injuries can be complex and involve structures around the joint, especially due to rupture of the deep layer of the sixth extensor compartment [1].

It has been found that in the treatment of traumatic ruptures of the clinically diagnosed instability of the DRUJ, ruptures of the ulnar side of the TFCC play an essential role. Especially, the ulnar-sided tears are further divided into those that result in significant instability and those that are not associated with instability. Furthermore, it was shown that the deep insertion of the TFCC may have isolated tears and therefore cannot be seen during standard wrist arthroscopy.

The development of arthroscopic procedure, the current state and the practical approach are illustrated below.

Classification

The classification of traumatic lesions of the TFCC by Palmer [2] is still a domain of arthroscopy. This classification describes these lesions of the TFCC according to

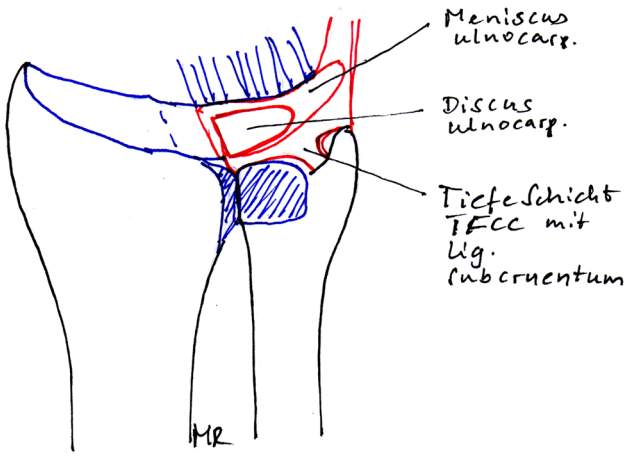

Fig. 1 Anatomy of the distal radioulnar joint and TFCC

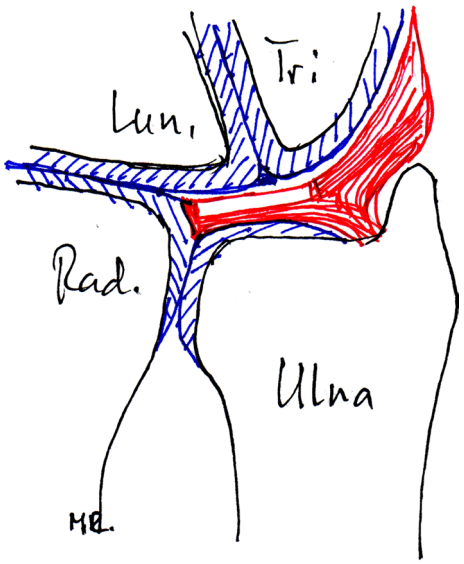

Fig. 2 Cross section of the DRUJ and TFCC

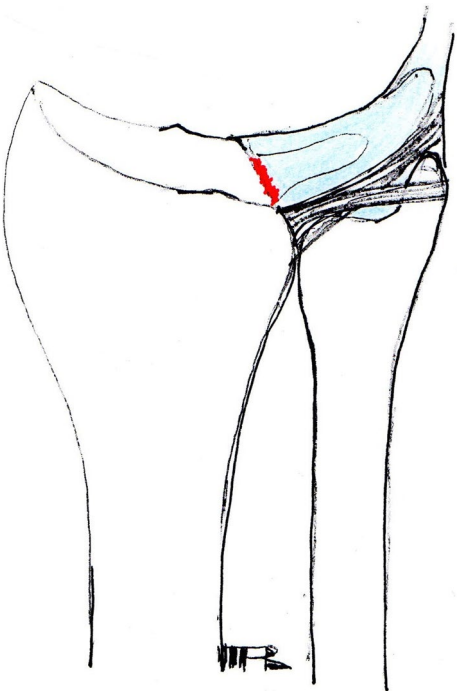

Fig. 3 Palmer 1A lesion with central perforation

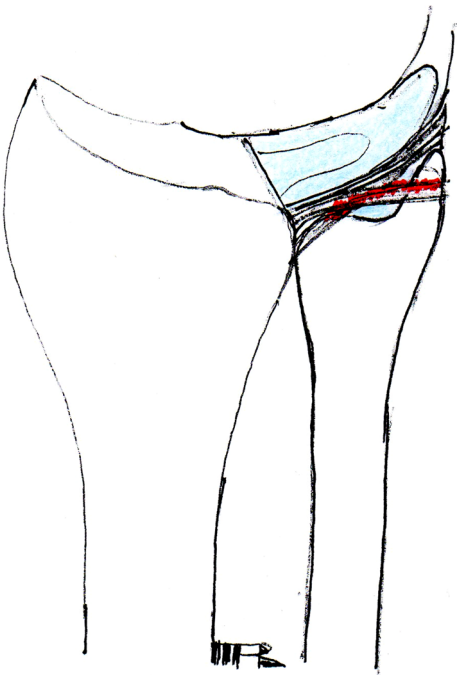

Fig. 4 Palmer 1B with ulnar avulsion and distal ulnar fracture

the anatomic location in central (1A), demolition of the ulnar styloid with or without fracture (1B), palmar (1C) and radial (1D). It was based initially on arthrographic and intraoperative findings (Figs. 3, 4, 5, 6, 7). Palmer 2 describes degenerative injury of the TFCC: height reduction and TFCC wear (2A), TFCC wear with lunate and/or ulnar chondromalacia (2B), TFCC perforation with lunate and/or ulnar chondromalacia (2C), TFCC perforation with lunate and/or ulnar chondromalacia and lunotriquetral ligament perforation (2D), TFCC perforation with lunate and/or ulnar chondromalacia, lunotriquetral ligament perforation, and ulnocarpal arthritis (2E).

Atzei has published a classification on ulnar traumatic lesions of the TFCC which distinguish the purely superficial tears (without instability of the joint), tears of the deep insertion (with instability of the joint), and combined injuries [3].

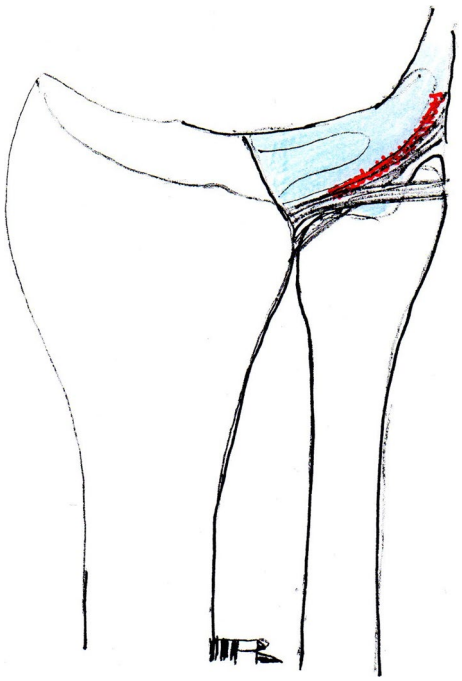

Fig. 5 Palmer 1B with ulnar avulsion and ligamentous lesion

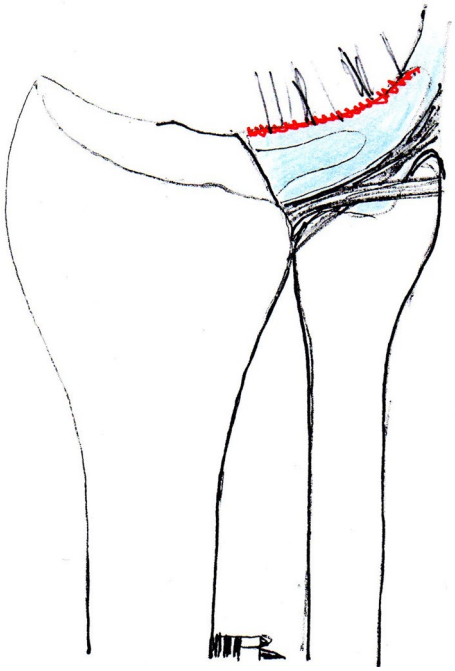

Fig. 6 Palmer 1C with distal avulsion

Nakamura has worked up the TFCC shares histologically and demonstrated that both dorsal and palmar sharpey fibers are present as well as in the deep insertion of the bone. These sharpey fibers give the complex a stabilizing effect [4].

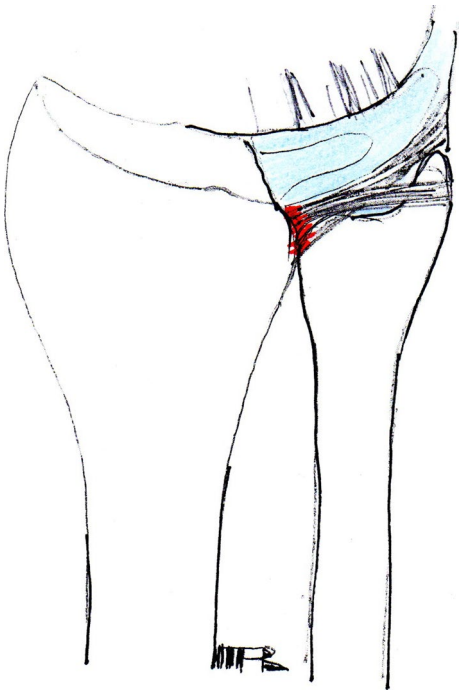

Fig. 7 Palmer 1D radial avulsion with or without sigmoid notch fracture

In addition, isolated longitudinal tears of ulnotriquetral ligaments are observed and can cause ulnar-sided pain without instability [5].

Diagnostics

The arthrography of the wrist, even when all 3 compartments are injectcted, has proven to be insecure [6], but is specifically helpful for the detection of avulsion in the fovea [7]. More sophisticated imaging techniques such as CT arthrography and MR arthrography improve the sensitivity and specificity significantly [8].

The arthroscopy can detect minor tears of the TFCC and cartilage damage and assess the integrity and power of intrinsic and extrinsic ligaments and TFCC of the ulnoradial ligaments accurately and is considered the gold standard for diagnosis of pathologies in the wrist.

Insertion of a small joint arthroscope into the proximal and distal parts of the DRUJ allows visualization of the proximal pouch of the DRUJ, the joint surfaces of the sigmoid notch and the ulnar head, the convexity of the ulnar head and the proximal ulnar-sided surface of the TFCC [9].

Further required is a precisely adjusted X-ray of the wrist joint in two planes (posterior-anterior and lateral) for the evaluation of ulnar variance. Therefore, the wrist joint should be in neutral position with no flexion and the PA projection is obtained in 90° abduction of the shoulder. Lateral projection is obtained with elbow flexed to 90° and

adducted against the trunk [10]. Stress X-ray may help to clarify a dynamic ulnar impaction syndrome. It is most important to make sure that the bony congruence of the DRUJ is intact. Even small misalignments, e.g. after a distal radius fracture can cause instability and ulnar wrist pain [11, 12].

Slight misalignments after a more proximal radius fracture can also lead to symptomatic instability of the DRUJ. Also remaining radial translocations of the distal fragment with otherwise correct position of the fracture can cause instability of the DRUJ surfaces [13].

The diagnostic role of other imaging techniques is not clarified finally. The accuracy of conventional MRI with respect to the injuries of the TFCC, especially under conditions of daily practice, is still insufficient [14]. In differential diagnosis aspects and for clarification of associated injuries, however, this may be helpful. The information from high-resolution MRI, arthro-CT and arthro-MRI is valuable also for the experienced arthroscopist. In particular, partial ruptures of the deep insertion of the TFCC are often seen on MRI; arthroscopically, they can be difficult to detect. Close cooperation between the radiologist and the hand surgeon would be desirable.

Arthroscopic diagnosis

Arthroscopy of the ulnar part of the wrist in conventional technology under distraction with a 2.7 or 1.9 mm arthroscope through the 3/4-portal is shown. The TFCC is examined with the retractors on the 6R or 4/5 portal and the cartilage assessed particularly on the ulnar pole of the lunate and palpated with the retractor. The LT-ligament can be best visualized through the 6R portal for palpation or debridement.

Complete and partial rupture of the superficial ulnar tears arthroscopically is easy to detect. Isolated deep lesions cannot be seen during standard arthroscopy of the radiocarpal joint, since the visible superficial portions of the TFCC completely hide the deep structures. If the tension of the TFCC is reduced it can be detected by a retractor (trampoline-test). A striking synovitis can arouse the suspicion of a deeper lesion.

Radial tears are distinguished in central tears and tears affect the ligamentous share. In these cases pure debridement is not sufficient [15].

Conservative treatment

Both in the acute or chronic phase of TFCC lesions conservative treatment is initially used. Immediately after an injury of the wrist by extension or rotation trauma, the joint is immobilized by a splint. How long and what joints should be immobilized, is not substantiated by data; 4–6 weeks in an ulnar forearm brace seems to be an often used pragmatic solution, but this is not proven by sufficient studies. Park et al. reported that conservative treatment is sufficient [16] in approximately half of patients with a clinical diagnosis of TFCC injury. Patients with marked instability of the DRUJ were not taken into account in this study.

To stabilize the DRUJ in the post-acute phase a dorsopalmar brace should be taken into consideration. That brace should compress the forearm in the transverse while wrist and elbow are free in motion [17]. In chronic situations, when trauma is weeks or months ago, proprioceptive exercises for muscular stabilization of the DRUJ are necessary.

Operative treatment

The most important assessment to make in a patient with an acute (Palmer 1) TFCC injury is whether the DRUJ is stable. If there is DRUJ instability, then surgical treatment needs to stabilise it. If there is a significantly displaced fracture contributing to DRUJ instability, such as a large ulnar styloid fracture, then this needs to be surgically fixed. If there is a position of forearm rotation where the DRUJ is acceptably stable, then a period of immobilisation in a long-arm cast in this position would allow well-vascularised peripheral tears to heal. This may be supplemented with temporary pin fixation of the distal ulna to the distal radius. After 3 months with persisting symptoms of non-operative management, surgery should be considered. The surgical options for acute TFCC tears include repair of the tear, debridement of the tear, ulnar shortening, and ulnar head resection. The decision as to which is the most appropriate procedure depends upon the tear location, tear type, patient symptoms, ulnar variance and DRUJ stability. In general, acute peripheral tears should be repaired. Stable central tears without DRUJ instability have excellent pain relief with arthroscopic-assisted debridement. In the situation of an ulnar positive variance, an ulnar shortening procedure should be considered in order to relieve the axial loads through the TFCC.

Degenerative TFCC tears (Class II) are usually the result of ulnocarpal impaction, and therefore the mainstay of surgical treatment includes ulnar shortening osteotomy or ulnar head resection [18].

If, after conservative treatment, ulnar-sided pain is persisting, an arthroscopic evaluation and treatment is useful (Figs. 8, 9).

Whether surgical intervention is necessary, depends very much on the situation and activity of the patient. A spontaneous improvement of the pain is possible even after several months.

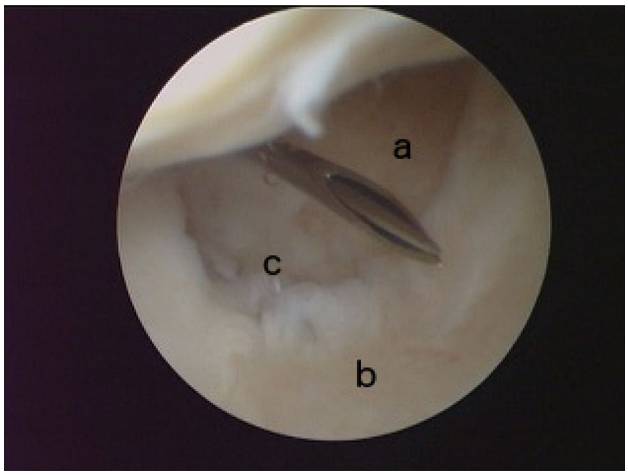

Fig. 8 Arthroscopic detection of an ulnar-sided TFCC tear, Palmer 1B *a* Triquetrum, *b* TFCC, *c* Rupture area

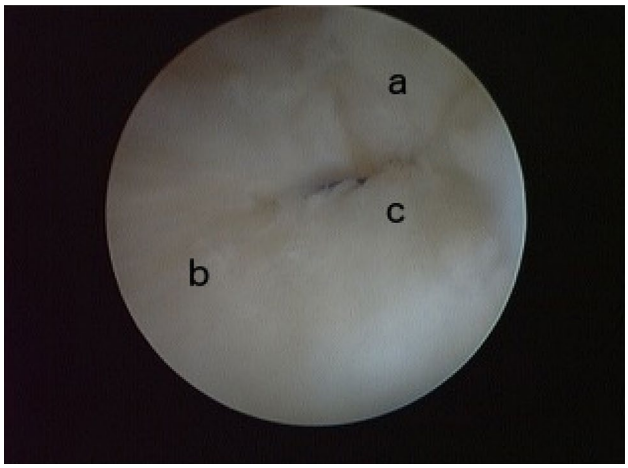

Fig. 9 Intraoperative aspect after arthroscopic suture *a* Triquetrum, *b* TFCC, *c* Suture

However, Moritomo reported that of 35 patients with proven avulsion of the TFCC into the fovea, 16 were symptom-free after conservative treatment [7]. The results after operative treatment vary according to personal experience of the surgeon and not necessarily from the time of surgery. Nakamura et al. however observed poorer results when arthroscopic refixation was performed later than 7 months, or open surgery later than 1 year after the trauma [4]. Furthermore the adequate performed debridement of scar tissue and sufficiently freshened bone is important for the outcome. Anyway, the ulnoradial ligaments remain in position due to their interwoven architecture involving the TFCC. Therefore, they are suitable for reinsertion after avulsion from the fovea for several months.

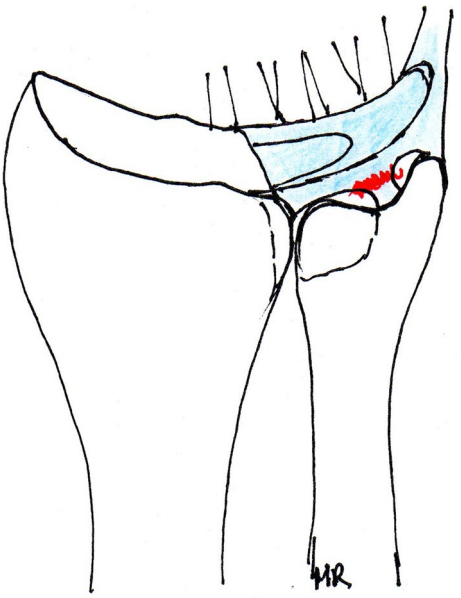

Fig. 10 Tear of deep fibres of the TFCC in the fovea

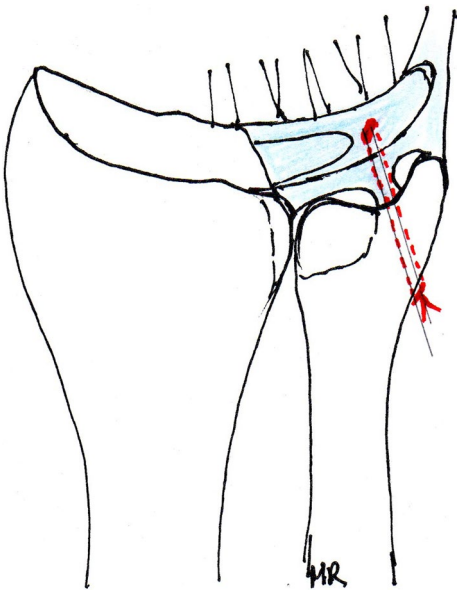

Fig. 11 Suturing transosseously at Palmer lesions 1B, 1C and tear of deep fibres in the fovea

Arthroscopic treatment

The main therapeutic goal should be the stabilization of the DRUJ by reattachment of the torn ligaments in ulnar-sided ruptures to the deep fibers in the fovea. This reinsertion can be performed by transosseous suture, a suture anchor or open. The suture anchor is placed directly in the fovea, also known as “direct foveal portal” (Figs. 10, 11) [3].

A screw anchor reinforced with two threads is useful, so that dorsal and palmar portion of the ulnar TFCC can be reinserted simultaneously.

Atzei reported on 37 patients who were treated by this technique [3]; 18 patients were studied, 14 showed complete tears, 4 an isolated tear in the deep layer. The pain reduced from 8.2 to 1.2 on the VAS, the DASH score averaged with 10.5. Mayo Modified Wrist Score (MMWS) was excellent in 14, good in 3, and moderate in 1 patient.

Wysocki et al. reported on 29 patients, of whom 25 were followed up [19]. The pain dropped from an average of 5.4 to 0.9 on the VAS, the DASH score improved from 38 to 9.

Wolf et al. performed in 49 patients with Palmer 1B lesion without instability an arthroscopic TFCC reattachment [20]. There were 46 patients in follow-up after an average of 11 months and 4.8 years. The DASH score improved from 35 preoperatively to 22 after 11 months and 14 points after 4.8 years.

Nakamura et al. reported on 24 patients for whom the TFCC was arthroscopically reattached in a quite similar way but without using a bone anchor [15]. TFCC reattachment was performed using threads passed through the bone and TFCC by using K-wires and needles.

Shinohara et al. report on the operation in the same arthroscopic technique on 11 patients with an average of 94 points (MMWS) [21].

MMWS was excellent in six, good in four and moderate also in four patients. Seven patients were free of pain; four had mild pain during exercise.

Another technique for reinsertion is described by Iwasaki where the avulsed portion of the deep component of TFCC is anchored to the ulnar fovea by means of a repair suture passed through the created osseous tunnel from the ulnar neck to the foveal surface. Besides reduction of wrist pain in all patients, MMWS was 92.5 in average and all patients were rated as having excellent or good results. DASH score improved from 59.5 preoperatively to 7.7 postoperatively and magnetic resonance images at 12 weeks postoperatively showed findings indicating attachment of the triangular fibrocartilage complex (TFCC) to the fovea [22].

For the treatment of superficial lesions even solely, debridement is described. It has been reported on the one hand with good results: postoperative range of motion averaged 99.2 % for the extension/flexion arc, 95.5 % for the radial/ulnar deviation arc, and 99.4 % for the pronation/supination arc of motion when compared with the contralateral wrist. The DASH score was 17.02. There was a significant reduction in pain. The grip strength was 96.7 %, pulp-to-pulp pinch 101.9 %, the ulnar variance -0.12 ± 1.69 mm and the MMWS was rated excellent in 48 % of patients, good in 39 %, fair in 13 %, and poor in 0 % [23]. On the other hand TFCC debridement has been found not effective with little benefit on the clinical course of recalcitrant ulnar wrist pain [24].

Conclusion

It is important that the TFCC is recognized as a three-dimensional structure. The origin of the deep ulnoradial fibers in the fovea is closer to the radius. The origin of the superficial fibers is located further away from the radius, so that the approach angle of the deep fibers is greater and therefore more effective than the superficial fibers [25]. Clinical observations have also shown that the deep part of the TFCC can tear off and isolated ulnar ligament ruptures can involve the deep and superficial ligament share in varying degrees.

By arthroscopically assisted surgery, these injuries can be reconstructed anatomically correct. More severe injuries are associated with a major instability and less suitable for the arthoscopic approach. With careful diagnosis and observation of contraindications, especially a bone incongruity of DRUJ after fractures and ulna plus situation where these injuries are not rare, one can reliably expect excellent and good results [26].

Conflict of interest Lijo Mannil, Wolfgang Martin, Janosch Dahmen, Thomas Witte, Philip Juten, Frauke Deneken, Martin Räder and Heinz-Herbert Homann declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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