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CONTEMPORARY IMAGING, ARTHROSCOPIC REPAIR, AND FUNCTIONAL REHABILITATION IN TRAUMATIC TRIANGULAR FIBROCARILAGE COMPLEX TEARS: A NARRATIVE REVIEW

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ABSTRACT

Traumatic triangular fibrocartilage complex (TFCC) tears are an important cause of ulnar-sided wrist pain, reduced grip strength, restricted forearm rotation, and distal radioulnar joint (DRUJ) instability. Their diagnosis and management remain challenging because morphological abnormalities do not always correlate with symptoms or functional impairment. This narrative review summarizes contemporary concepts in the diagnosis, treatment, and rehabilitation of traumatic TFCC tears, with particular emphasis on modern imaging and arthroscopic technologies. English-language publications were identified through PubMed without restrictions on publication year. The reviewed evidence indicates that diagnosis should integrate the mechanism of injury, physical examination, bilateral assessment of DRUJ stability, and imaging findings. Magnetic resonance imaging and magnetic resonance arthrography improve visualization of TFCC lesions, but incidental abnormalities and variable diagnostic performance limit their use as isolated decision-making tools. DRUJ stability appears to be a key factor in treatment selection. Structured non-operative management may provide satisfactory outcomes in patients with a stable DRUJ, whereas persistent symptoms, mechanically unstable tears, and foveal detachment may require surgical intervention. Contemporary arthroscopic options include all-inside repair, suture-anchor fixation, and transosseous techniques, although current evidence does not establish a single superior method. Postoperative rehabilitation protocols remain heterogeneous, and validated criteria for progression and return to work or sport are lacking. Future research should focus on standardized diagnostic pathways, comparative evaluation of repair techniques, objective functional monitoring, and patient-centered return-to-activity outcomes. Modern technologies should support, rather than replace, integrated clinical and functional assessment.

KEYWORDS

Triangular Fibrocartilage Complex, Distal Radioulnar Joint, Magnetic Resonance Imaging, Wrist Arthroscopy, Rehabilitation, Functional Outcomes

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Introduction

The triangular fibrocartilage complex (TFCC) is a key stabilizing structure on the ulnar side of the wrist. It consists of several interconnected fibrocartilaginous and ligamentous components involved in load transmission across the ulnocarpal joint, stabilization of the distal radioulnar joint (DRUJ), and coordinated movement of the wrist and forearm (Herzberg et al., 2021). In particular, the dorsal and volar radioulnar ligaments and their foveal attachments play a fundamental role in maintaining DRUJ stability during pronation and supination (Herzberg et al., 2021). Injury to these structures may therefore result not only in persistent ulnar-sided wrist pain but also in mechanical symptoms, reduced grip strength, restricted forearm rotation, and clinically significant DRUJ instability (Herzberg et al., 2021). However, the complex three-dimensional anatomy of the TFCC and the inconsistent terminology used to describe its individual components may hinder the interpretation and comparison of clinical, imaging, and surgical studies (Herzberg et al., 2021; van der Post et al., 2022).

Traumatic TFCC tears may result from a fall onto an outstretched hand, forced wrist extension, axial loading combined with ulnar deviation, or excessive forearm rotation (Adams & Holley, 1993; Frank et al., 2015). They may occur as isolated soft-tissue injuries or coexist with distal radius fractures, ulnar styloid fractures, carpal ligament injuries, and DRUJ instability (Adams et al., 1996). These lesions form a heterogeneous spectrum that includes central perforations and peripheral, foveal, and radial-sided tears (Herzberg et al., 2021). Their clinical significance depends not only on the anatomical location of the lesion but also on its chronicity, vascularity, tissue quality, associated osseous morphology, and effect on DRUJ stability (Bednar et al., 1991; Herzberg et al., 2021). Consequently, a TFCC abnormality identified on imaging should not automatically be regarded as the source of a patient's symptoms, particularly because structural abnormalities may also be observed in asymptomatic individuals (Iordache et al., 2012).

The diagnosis of traumatic TFCC injury remains challenging. Ulnar-sided wrist pain has a broad differential diagnosis, and individual physical examination tests are not always sufficiently specific to determine the exact location and functional significance of a lesion (Ou Yang et al., 2021; Schmauss et al., 2016). Conventional radiographs are important for identifying fractures, assessing ulnar variance, and detecting associated abnormalities, but they do not allow direct visualization of the TFCC (Lindau et al., 1997; Ryoo et al., 2023). Magnetic resonance imaging and magnetic resonance arthrography permit non-invasive or minimally invasive assessment of the complex, although their diagnostic performance varies according to magnetic field strength, imaging protocol, lesion location, and the experience of the interpreting clinician (Anderson et al., 2008; Boer et al., 2018). Wrist arthroscopy continues to provide the most detailed assessment of TFCC morphology and stability while also enabling simultaneous treatment. However, it is an invasive procedure and should be interpreted in conjunction with the patient's symptoms, clinical examination findings, and imaging results (Boer et al., 2018; Herzberg et al., 2021; Iordache et al., 2012).

Treatment depends on both the characteristics of the injury and the individual functional needs of the patient. Initial non-operative management may include activity modification, temporary immobilization, pharmacological pain management, and gradually introduced rehabilitation (Choi et al., 2024; McNamara et al., 2020). Available evidence indicates that appropriately selected patients with traumatic TFCC tears, particularly those without clinically significant DRUJ instability, may achieve satisfactory outcomes following structured conservative treatment, although treatment protocols remain heterogeneous and the quality of evidence is limited (Choi et al., 2024; Sander et al., 2021). Surgical treatment is considered primarily in patients with persistent symptoms, mechanical instability of the lesion, or clinically significant DRUJ instability (Dunn et al., 2020; Koeyvoets et al., 2023). Advances in wrist arthroscopy have led to the increasing use of minimally invasive treatment methods, including all-inside techniques, suture-anchor fixation, and transosseous repair through bone tunnels (Afifi et al., 2022; Yao & Lee, 2011). However, available studies do not identify a single technique that is optimal for all types of TFCC tears. The choice of procedure should therefore take into account the location and chronicity of the lesion, tissue quality, DRUJ stability, and the patient's functional requirements (Afifi et al., 2022; Koeyvoets et al., 2023; Liu et al., 2021).

The relevance of contemporary technologies is not limited to the detection and surgical treatment of TFCC injuries. The increased availability of MRI and MRA may also lead to the identification of abnormalities without clinical significance, as TFCC abnormalities are present in a proportion of asymptomatic individuals (Anderson et al., 2008; Boer et al., 2018; Iordache et al., 2012). Imaging findings should therefore be interpreted in relation to the mechanism of injury, the patient's symptoms, and DRUJ stability. Improved clinical–imaging correlation may reduce the use of invasive procedures for incidental or clinically irrelevant morphological abnormalities. In the future, standardized measurements of range of motion and grip strength, electronic functional assessment tools, and solutions enabling remote rehabilitation monitoring may support more individualized management. However, their usefulness in patients treated for TFCC injuries requires confirmation in further studies. Treatment outcomes should be assessed not only in terms of anatomical findings and clinical parameters but also according to the patient's ability to return to work, sports, and activities of daily living (Silber et al., 2023).

The aim of this narrative review is to summarize and critically evaluate contemporary concepts in the diagnosis, treatment, and rehabilitation of traumatic TFCC tears, with particular emphasis on the role of modern imaging and arthroscopic technologies. The review addresses clinically relevant anatomy, mechanisms and classifications of injury, physical examination, the use of MRI, MRA, and arthroscopy, indications for conservative and surgical treatment, contemporary repair techniques, and methods of assessing functional outcomes. Particular attention is given to the role of clinical–imaging correlation in reducing unnecessary interventions, the importance of DRUJ stability in treatment selection, and return to work, sports, and daily activities as relevant measures of treatment effectiveness. The principal areas of uncertainty and priorities for future research are also identified.

Methodology

This article was prepared as a narrative review of the literature concerning contemporary concepts in the diagnosis, treatment, and rehabilitation of traumatic injuries of the triangular fibrocartilage complex of the wrist. The scope of the review included clinically relevant TFCC anatomy and biomechanics, mechanisms and classifications of injury, clinical presentation and physical examination, imaging and arthroscopic diagnostics, conservative and surgical treatment, rehabilitation, functional outcomes, prognostic factors, and complications. The purpose of the adopted methodology was to present the current state of knowledge, compare the principal diagnostic and therapeutic concepts, and identify areas in which the available evidence remains limited or inconclusive.

The literature search was conducted in the PubMed electronic database. No restriction on publication year was applied in order to include both classic anatomical, histological, and biomechanical studies and contemporary publications concerning magnetic resonance imaging, magnetic resonance arthrography, arthroscopy, conservative treatment, repair techniques, reconstruction, and rehabilitation. Only publications written in English were considered eligible for inclusion. The final search was conducted on August 2, 2026.

The search strategy was developed using keywords and indexing terms related to the TFCC and the individual thematic areas of the review. The terms were combined using the Boolean operators “AND” and “OR.” The search included, among others, the following terms: “triangular fibrocartilage complex,” “TFCC,” “TFCC tear,” “traumatic TFCC injury,” “peripheral TFCC tear,” “foveal TFCC tear,” “distal radioulnar joint instability,” “ulnar-sided wrist pain,” “wrist arthroscopy,” “conservative TFCC tear treatment,” “nonoperative TFCC tear treatment,” “surgical TFCC repair,” “TFCC suture anchor,” “TFCC tear rehabilitation,” “TFCC tear clinical outcomes,” and “TFCC tear arthroscopy complications.”

To improve the completeness of the search, supplementary queries were also conducted for the individual thematic areas of the article. The terms “triangular fibrocartilage complex” and “TFCC” were combined with terms relating to anatomy, vascularity, biomechanics, Palmer classification, DRUJ stability, magnetic resonance imaging, magnetic resonance arthrography, arthroscopic debridement, peripheral and foveal repair, all-inside techniques, bone anchors, bone tunnels, ligament reconstruction, postoperative rehabilitation, return to work, and return to sports activity.

The review included original clinical, diagnostic, anatomical, histological, and biomechanical studies, observational and comparative studies, case series, systematic reviews, meta-analyses, and narrative reviews considered relevant to the analyzed topic. Classic publications forming the basis of the contemporary understanding of TFCC anatomy, function, vascularity, and classification were also included. Priority was given to primary studies, systematic reviews, and meta-analyses, whereas narrative reviews were used mainly to provide broader clinical context and to identify additional publications.

Studies not directly related to the TFCC, publications concerning exclusively degenerative lesions without a relevant relationship to traumatic injuries, articles published in languages other than English, conference abstracts without an available full text, and publications duplicating results previously reported for the same or partially overlapping patient population were excluded. Studies involving mixed populations were included when data relating to traumatic TFCC injuries could be extracted or when the reported findings were directly relevant to their diagnosis, treatment, or rehabilitation. Single case reports were included only when they described an unusual mechanism of injury, a novel diagnostic or surgical technique, or a rare and clinically relevant complication.

The literature search, study selection, and evaluation of publications were performed by the authors. During the first stage, the titles and abstracts of all records identified in PubMed were reviewed. Publications clearly unrelated to the thematic scope of the review were excluded at this stage. The full texts of articles considered potentially relevant were then assessed. When publications reported data from the same or partially overlapping population, preference was given to the study with the larger sample, longer follow-up period, or more detailed description of the methodology and outcomes.

The PubMed search identified 7,271 records. Following title and abstract screening, 6,942 publications were excluded, and the full texts of 329 articles were assessed in detail. After application of the eligibility criteria, 286 publications were excluded. The main reasons for exclusion were the absence of a direct relationship to traumatic TFCC injuries, an exclusive focus on degenerative lesions, inability to extract relevant data, duplication of results from the same population.

Data from the eligible articles were collected in a structured spreadsheet. The extracted information included authors, year of publication, study design, sample size and population characteristics, type and classification of TFCC injury, DRUJ stability, diagnostic or therapeutic method, immobilization and

rehabilitation protocol, duration of follow-up, pain and functional outcomes, range of motion, grip strength, return to work or sports activity, treatment failures, complications, and the main methodological limitations.

Because of the narrative nature of the review, no formal quantitative risk-of-bias assessment or meta-analysis was performed. However, the interpretation of the findings considered study design, sample size and selection, the reference standard used, duration of follow-up, completeness of outcome reporting, and the appropriateness of the methods in relation to the research question. When findings differed between publications, possible sources of heterogeneity were examined, including lesion location and chronicity, DRUJ stability, diagnostic criteria, surgical techniques, rehabilitation protocols, and outcome assessment methods.

The collected evidence was organized into thematic areas covering TFCC anatomy and biomechanics, mechanisms and classifications of injury, clinical presentation and physical examination, imaging and arthroscopic diagnostics, conservative treatment, surgical treatment, rehabilitation, functional outcomes, prognostic factors, and complications. The findings were presented as a qualitative narrative synthesis, with particular emphasis on areas of agreement, discrepancies between studies, the clinical significance of the results, and topics requiring further investigation.

Because the study was based exclusively on the analysis of previously published literature and did not involve human participants or the use of identifiable patient data, approval from an ethics committee was not required.

Results

Clinical Significance of TFCC Anatomy and Biomechanics

The triangular fibrocartilage complex is a complex system of fibrocartilaginous and ligamentous structures responsible for stabilizing the ulnar side of the wrist, transmitting loads, and controlling the distal radioulnar joint. Its principal components include the articular disc, the volar and dorsal radioulnar ligaments, the ulnocarpal ligaments, and structures closely related to the extensor carpi ulnaris tendon sheath. From a clinical perspective, the attachments of the deep fibers of the radioulnar ligaments within the ulnar fovea are of particular importance, because their integrity is essential for normal DRUJ stability during pronation and supination (Herzberg et al., 2021; van der Post et al., 2022).

The individual components of the TFCC differ in their histological structure and vascular supply. The central portion of the articular disc is poorly vascularized, which limits its capacity for spontaneous healing. In contrast, the peripheral portions of the complex receive a blood supply from the surrounding tissues and therefore have greater healing potential (Bednar et al., 1991). These differences have direct therapeutic implications. Central, stable perforations are more commonly treated with arthroscopic debridement, whereas peripheral or foveal tears with adequate tissue quality may be suitable for repair or reattachment (Herzberg et al., 2024).

Because of the complex three-dimensional structure of the TFCC, lesions visible from the radiocarpal joint do not always reflect the condition of the deeper foveal attachments. An apparently preserved surface of the articular disc may coexist with disruption of the deep fibers responsible for DRUJ stabilization (Herzberg et al., 2024). Therefore, morphological assessment of the tear should be supplemented by evaluation of its stability, both clinically and during arthroscopy (Herzberg et al., 2021).

Mechanisms and Classification of Traumatic TFCC Tears

Traumatic TFCC tears most commonly result from axial loading of the wrist, particularly during a fall onto an outstretched hand. The risk of injury increases when the wrist is simultaneously positioned in extension and ulnar deviation and the forearm is subjected to rotation (Chung et al., 2025). Another potential mechanism is sudden or excessive pronation or supination while the hand remains fixed (Herzberg et al., 2024). TFCC tears may occur as isolated injuries, but they frequently accompany distal radius fractures, ulnar styloid fractures, and other ligamentous injuries of the wrist (Lindau et al., 1997).

The Palmer classification remains the most commonly used historical system for categorizing TFCC lesions. Traumatic type 1 lesions include central, ulnar-sided, distal, and radial-sided tears. This classification is useful for describing the general location of a lesion, but it does not always reflect the contemporary understanding of foveal injuries, delamination of individual TFCC components, or the relationship between morphological appearance and DRUJ stability (Palmer, 1989).

More recent classification systems consider not only the location of the tear but also its chronicity, tissue quality, reparability, DRUJ stability, and associated anatomical characteristics, such as ulnar variance and the morphology of the sigmoid notch of the radius (Herzberg et al., 2024). This approach has greater clinical relevance because morphologically similar tears may require different treatment depending on the condition of the deep radioulnar ligaments and the foveal attachment (Herzberg et al., 2024).

Clinical Presentation and Physical Examination

The most common symptom of a traumatic TFCC tear is ulnar-sided wrist pain. Symptoms may worsen during forceful gripping, lifting, weight-bearing through the hand, and forearm rotation. Patients may also report clicking or snapping, a sensation of instability, reduced grip strength, and restricted pronation or supination (Infanger & Grimm, 2009).

The clinical presentation is not specific, however. Similar symptoms may occur in extensor carpi ulnaris tendon disorders, ulnocarpal impaction syndrome, pisotriquetral joint pathology, carpal ligament injuries, carpal fractures, and disorders of the DRUJ. Therefore, the examination should include a systematic assessment of the entire wrist and forearm rather than focusing exclusively on the TFCC region (Ou Yang et al., 2021).

Clinical assessment may include the ulnar fovea sign, the ulnocarpal loading test, the press test, the DRUJ ballottement test, and evaluation of DRUJ stability in the neutral position, pronation, and supination (Ou Yang et al., 2021). No single test, however, provides sufficient diagnostic accuracy for all types of TFCC tears. Examination findings may depend on the type and location of the lesion and on the presence of associated pathology. Clinical test results should therefore be interpreted in conjunction with the mechanism of injury, pain location, other examination findings, and comparison with the contralateral limb (Schmauss et al., 2016).

Assessment of DRUJ stability is particularly important because disruption of the foveal TFCC attachment may result in instability of this joint (Atzei et al., 2015). Increased and symptomatic translation of the ulnar head relative to the radius, particularly when it differs from the contralateral side, may indicate insufficiency of the DRUJ stabilizing structures. Because clinical assessment of joint translation is partly subjective, it should be performed bilaterally in the neutral position, pronation, and supination. Comparison with the contralateral limb helps reduce the risk of incorrectly interpreting patient-specific physiological joint mobility as pathological instability (Meaie et al., 2024).

Imaging Diagnostics and the Role of Arthroscopy

Conventional radiography is important in the initial assessment of wrist trauma because it allows the detection of osseous abnormalities and the evaluation of parameters such as ulnar variance. However, it does not permit direct assessment of the cartilage and ligamentous structures forming the TFCC, which may be visualized using magnetic resonance imaging or magnetic resonance arthrography (Pavić et al., 2022). Ulnar variance should be measured in a standardized position and interpreted cautiously because its value changes according to forearm rotation and loading of the extremity during gripping (Jung et al., 2001).

Magnetic resonance imaging enables assessment of the articular disc, the radioulnar ligaments, and associated soft-tissue injuries. Its diagnostic performance depends, among other factors, on magnetic field strength, the use of a dedicated wrist coil, and the experience of the individual interpreting the images (Anderson et al., 2008). Anderson et al. (2008) reported that 3.0-T MRI demonstrated greater sensitivity, specificity, and accuracy than 1.5-T MRI; however, higher field strength alone does not guarantee a correct diagnosis.

Magnetic resonance arthrography may improve the detection of some full-thickness perforations and tears communicating with the joint cavity. Its advantage over conventional MRI is usually modest, however, and the examination requires intra-articular administration of contrast medium, with additional burden and risks related to the invasive nature of the procedure (Boer et al., 2018). The indication for MRA should therefore be considered in the context of the findings of a previous MRI examination, the suspected location of the tear, and the potential influence of the result on subsequent management.

The interpretation of imaging studies must take into account the possibility of TFCC abnormalities in asymptomatic individuals. Morphological abnormalities and full-thickness tears may represent incidental findings, and their prevalence increases with age. MRI findings alone should therefore not determine eligibility for surgical treatment without consistency with the patient's history and clinical examination findings (Iordache et al., 2012).

Arthroscopy is used as the reference standard in studies evaluating the diagnostic accuracy of MRI and MRA and allows direct assessment of TFCC morphology and stability (Anderson et al., 2008; Boer et al.,

2018). During the procedure, the trampoline test and hook test may be performed, and the identified lesion can be treated simultaneously (Herzberg et al., 2021). The limitations of arthroscopy include its invasive nature and the possibility of incomplete visualization of the deep fibers of the foveal attachment when assessment is performed exclusively from the radiocarpal joint. In selected cases, additional DRUJ arthroscopy may be required (Herzberg et al., 2024).

Conservative Treatment

Non-operative treatment may represent the initial management strategy in patients without clinically significant DRUJ instability, particularly when there is no joint subluxation or complete detachment of the foveal TFCC attachment (Choi et al., 2024; Sander et al., 2021). Conservative management may include temporary restriction of upper-extremity loading, the use of an orthosis or immobilizing cast, non-steroidal anti-inflammatory drugs, and physiotherapy or gradually introduced rehabilitation (Sander et al., 2021).

The extent of immobilization should take into account DRUJ stability and the suspected type of injury. In traumatic tears requiring restriction of pronation and supination, immobilization extending above the elbow may be more effective. Xiao et al. (2021) demonstrated that above-elbow immobilization was associated with better outcomes than short-arm immobilization, particularly in patients without DRUJ subluxation. The systematic review by Choi et al. (2024) also identified short-term above-elbow immobilization as an effective option in selected Palmer type 1B tears, whereas short-arm immobilization, DRUJ subluxation, and complete detachment of the foveal attachment were associated with a greater risk of failure of conservative treatment. In a study of patients with a stable DRUJ, the use of a forearm orthosis for two weeks, followed by nighttime and as-needed use, produced satisfactory outcomes, with full weight-bearing permitted after six weeks (Sander et al., 2021).

Conservative rehabilitation should be introduced gradually and adapted to the patient's symptoms, DRUJ stability, and stage of healing. A structured program may include orthosis use, range-of-motion exercises, progressive strengthening of the upper-extremity musculature, proprioceptive training, and gradual increases in wrist loading (Tse et al., 2023). In a quasi-experimental study, a five-stage program combining orthoses and exercise was associated with reduced pain and improvements in range of motion, grip strength, upper-extremity function, and DRUJ stability in patients without substantial joint instability (Tse et al., 2023). Load progression should be individualized according to pain severity, range of motion, grip strength, functional performance, and DRUJ stability.

The evidence concerning the effectiveness of non-operative treatment remains limited and heterogeneous. The systematic review by Choi et al. (2024) included eight studies involving a total of 425 patients and 427 wrists, with substantial differences in tear characteristics, immobilization methods, follow-up duration, and outcome measures. Despite these limitations, the available evidence indicates that appropriately selected conservative treatment may produce satisfactory outcomes, particularly in patients with a stable DRUJ and no joint subluxation (Choi et al., 2024; Sander et al., 2021). Further prospective comparative and randomized studies using standardized eligibility criteria, treatment protocols, and outcome measures are nevertheless required (Choi et al., 2024).

Surgical Treatment

Surgical treatment is considered primarily in patients with persistent symptoms despite appropriately conducted conservative management, mechanical TFCC instability, or clinically significant DRUJ instability. Earlier surgical intervention may be justified in selected patients with high functional demands, including athletes, particularly in the presence of an unstable tear (McAdams et al., 2009). The choice of procedure should be based on the location and extent of the tear, DRUJ stability, lesion chronicity, tissue quality and reparability, and the presence of associated chondral or osseous abnormalities (Herzberg et al., 2024).

Central perforations involve the avascular portion of the articular disc and therefore have limited potential for spontaneous healing and are generally not suitable for direct repair (Bednar et al., 1991). In symptomatic Palmer type 1A central tears, arthroscopic debridement and partial excision of unstable tissue are most commonly performed while preserving as much normal tissue as possible (McNamara et al., 2020). Before limiting the procedure to debridement alone, the stability of the peripheral and foveal TFCC attachments and the presence of features of ulnocarpal impaction should be assessed. Positive ulnar variance may be associated with poorer outcomes after arthroscopic debridement, but it does not automatically indicate the need for simultaneous ulnar shortening (Choi et al., 2024).

Peripheral TFCC tears may be repaired using inside-out, outside-in, or all-inside techniques (Yao & Lee, 2011). The choice of technique depends on the location and configuration of the tear, access to the relevant TFCC components, the risk of injury to neurovascular structures, and the surgeon's experience. Tears of the deep foveal attachment, particularly those associated with DRUJ instability, require anatomical reattachment of the TFCC to the ulnar fovea. This may be achieved using a suture anchor or sutures passed through one or more bone tunnels (Afifi et al., 2022). A direct comparative study demonstrated good and similar outcomes with both methods; therefore, the available evidence does not allow either suture-anchor fixation or transosseous repair to be regarded as the universally optimal technique (Afifi et al., 2022).

In chronic tears, tissue quality and retraction may preclude direct TFCC repair. In cases of an irreparable tear with persistent symptomatic DRUJ instability, anatomical reconstruction of the radioulnar ligaments using a tendon graft may be considered, provided that advanced degenerative changes of the DRUJ are absent (Atzei et al., 2023). Before reconstruction, joint congruence and osseous deformity should be assessed because abnormal anatomy of the distal radius or sigmoid notch may require separate corrective treatment (Adams & Berger, 2002).

In patients with concomitant positive ulnar variance and clinical or imaging features of ulnocarpal impaction, TFCC repair or debridement alone may not eliminate excessive loading on the ulnar side of the wrist. In appropriately selected cases, an unloading procedure, including ulnar shortening osteotomy, may be considered (Minami & Kato, 1998). Positive ulnar variance should not, however, be treated as an independent indication for osteotomy in every patient with a traumatic TFCC tear. In central traumatic tears, initial arthroscopic debridement followed by observation may be justified, while ulnar shortening may be reserved as a secondary procedure for patients with persistent symptoms of ulnocarpal impaction (Choi et al., 2024).

Postoperative Rehabilitation

Rehabilitation following TFCC repair aims to protect the healing attachment, reduce the risk of secondary injury, and gradually restore mobility, strength, and upper-extremity function. At the same time, excessively prolonged immobilization may contribute to loss of range of motion and delay functional recovery. There is currently no universally accepted rehabilitation protocol following foveal TFCC repair, and recommendations vary among surgeons, therapists, and treatment centers (McCarron et al., 2024).

Following peripheral or foveal TFCC repair, a period of immobilization is usually used to restrict wrist motion and forearm pronation and supination. Controlled exercises involving forearm rotation and wrist flexion and extension are then introduced gradually. In the reviewed publications, wrist motion was initiated between 2 and 8 weeks after surgery, whereas pronation and supination were started between 2 and 12 weeks, indicating substantial heterogeneity in postoperative management (McCarron et al., 2023). A more recent meta-analysis of comparative studies suggested that restricting pronation and supination for approximately 4–6 weeks may provide better pain control and functional recovery than the immediate initiation of forearm rotation. However, immobilization restricting elbow motion did not demonstrate a significant advantage over methods allowing elbow movement with regard to final pain outcomes, grip strength, or wrist range of motion (Lee et al., 2026).

Resisted exercise, grip strengthening, and gradual axial loading are usually introduced after the initiation of range-of-motion exercises and once adequate pain control and DRUJ stability have been achieved. The timing of these interventions is not standardized and should take into account the type of repair, the stability obtained during surgery, the course of healing, and the functional demands of the patient (McCarron et al., 2024). Loading should be progressed gradually, particularly during activities involving forceful gripping, forearm rotation, and weight-bearing through the operated hand.

The available studies demonstrate substantial variation in the duration of immobilization, the initiation of motion, and the introduction of strengthening exercises. Although comparative studies of immobilization strategies have been published, high-quality evidence remains insufficient to define a single optimal protocol for all TFCC repair techniques and tear patterns (Lee et al., 2026; McCarron et al., 2023). Uniform, validated criteria for return to heavy manual work and sports have also not been established. In clinical practice, this decision should take into account pain severity, range of motion, grip strength, DRUJ stability, tolerance of activity-specific loads, and the assessment of both the surgeon and therapist. A systematic review found that most patients return to their previous work or sporting activity, although the reporting of return-to-activity timing and criteria remains heterogeneous (Silber et al., 2023).

Clinical Outcomes and Prognostic Factors

The available evidence indicates that, in appropriately selected patients, both conservative and surgical treatment may reduce pain and improve wrist function and grip strength (Choi et al., 2024; Sander et al., 2021). Direct comparison of the outcomes of different treatment methods is difficult, however, because of differences in tear classification, DRUJ stability, follow-up duration, treatment strategies, and the clinical outcome measures used (Choi et al., 2024; McNamara et al., 2020).

The most consistently reported factors associated with successful conservative treatment include a stable DRUJ, absence of joint subluxation on imaging, and immobilization that effectively restricts forearm rotation. By contrast, an increased risk of treatment failure is associated with clinical DRUJ instability, joint subluxation, short-arm immobilization that does not include the elbow, and complete detachment of the foveal TFCC attachment (Choi et al., 2024; Xiao et al., 2021).

Prognostic factors following surgical treatment have not been clearly established. A longer duration of symptoms, greater preoperative pain, and poorer preoperative function may be associated with worse patient-reported outcomes after open TFCC repair, although the available predictive models explain only a small proportion of the variability in treatment outcomes (Feitz et al., 2021). The effects of age, injury characteristics, degenerative changes, and ulnar variance have also been investigated, but the findings remain heterogeneous. In particular, a systematic review found no convincing evidence of an independent association between positive ulnar variance and poorer outcomes after TFCC repair (Jung et al., 2018). Improvement in wrist stability and function does not always result in complete pain relief. Outcomes should therefore be assessed separately in terms of pain, DRUJ stability, range of motion, grip strength, and functional performance (Liu et al., 2021; McNamara et al., 2020).

Reported complications of surgical TFCC treatment include injury or irritation of the sensory branches of the ulnar nerve, extensor tendon inflammation or injury, particularly involving the extensor carpi ulnaris tendon, stiffness, restricted forearm rotation, fractures associated with the creation of bone tunnels, and persistent pain or instability (Mak & Ho, 2024). The risk and type of complication depend on the extent and complexity of the procedure. In one study comparing open and arthroscopic foveal repair, recurrent instability occurred in 12.6% of patients and ECU tendinitis in 3.8%. These values relate to a specific study population and should not be generalized to all surgical techniques (Lee et al., 2024). Heterogeneity in surgical procedures, definitions of complications, and follow-up periods makes it difficult to establish a single reliable rate of adverse events for TFCC surgery as a whole (Liu et al., 2021; Mak & Ho, 2024).

Discussion

The findings of this review indicate that the principal challenge in the diagnosis and treatment of traumatic TFCC tears is not merely the detection of an anatomical abnormality, but rather the determination of its true clinical significance. The complex structure of the TFCC, the variability in tear patterns, and the possibility of morphological abnormalities in asymptomatic individuals mean that diagnosis should not be based on a single clinical test or an isolated imaging finding. The most appropriate approach is to integrate the mechanism of injury, pain location, physical examination findings, assessment of DRUJ stability, and imaging results, with arthroscopic evaluation reserved for selected cases.

Advances in magnetic resonance imaging, magnetic resonance arthrography, and dedicated wrist imaging protocols have improved the non-invasive detection of TFCC tears. However, the value of these technologies is limited by their dependence on magnetic field strength, coil quality, imaging protocol, tear location, and the experience of the interpreting clinician (Anderson et al., 2008; Boer et al., 2018). Assessment of the deep fibers of the foveal attachment remains particularly challenging because disruption of these structures may have greater functional significance than a superficial disc abnormality visible on MRI. At the same time, some abnormalities detected on imaging may represent incidental findings, particularly in older patients (Iordache et al., 2012). Therefore, higher imaging resolution and sensitivity do not necessarily translate into more accurate therapeutic decisions. More important is the correlation of imaging findings with symptoms, joint stability, and the patient's functional limitations.

Arthroscopy permits direct assessment of TFCC morphology and stability and allows treatment to be performed during the same procedure. It should not, however, be regarded as an automatic consequence of every abnormal MRI result. Arthroscopy is invasive, and its value depends on the systematic assessment of both the disc surface and the stability of its deep attachments. Evaluation performed exclusively from the radiocarpal joint may fail to identify some foveal tears; therefore, assessment of the DRUJ may be required in

selected cases (Herzberg et al., 2024). Appropriate use of modern diagnostic technologies should consequently aim not to increase the number of procedures, but to improve patient selection and reduce unnecessary invasive investigations and surgical interventions.

DRUJ stability appears to be the most important factor linking diagnosis with treatment selection. The location of the tear according to the Palmer classification does not always reflect the degree of functional insufficiency of the TFCC. Morphologically similar lesions may have different clinical implications depending on the integrity of the foveal attachment, tissue quality, and the presence of symptomatic instability. In clinical practice, DRUJ stability should be assessed bilaterally in the neutral position, pronation, and supination because physiological joint mobility varies among patients. Clinical findings should be interpreted together with symptoms and imaging rather than regarded as an independent diagnostic endpoint.

The importance of DRUJ stability is particularly evident when selecting patients for conservative treatment. Available evidence indicates that patients without DRUJ subluxation or substantial instability may achieve satisfactory outcomes following appropriately conducted immobilization and rehabilitation (Choi et al., 2024; Sander et al., 2021). The success of non-operative treatment depends, however, on appropriate patient selection and on whether the immobilization method effectively restricts pronation and supination. DRUJ subluxation, complete detachment of the foveal attachment, and insufficient restriction of forearm rotation are associated with a greater risk of failure of conservative management (Choi et al., 2024; Xiao et al., 2021). Non-operative treatment should therefore not be viewed merely as a waiting period before surgery, but as a structured intervention requiring appropriate immobilization, symptom control, gradual rehabilitation, and reassessment of joint stability.

Surgical treatment should be reserved primarily for patients with persistent symptoms despite appropriately conducted conservative management, mechanical instability of the tear, or clinically significant DRUJ instability. Earlier intervention may be justified in individuals with high functional demands, although participation in sport or physically demanding work should not replace assessment of tear morphology and stability. The objective of surgery is not merely to close a visible defect but to restore stability and function while minimizing additional tissue trauma.

Advances in arthroscopic technology have expanded the range of available procedures, including inside-out, outside-in, and all-inside techniques, suture-anchor fixation, and transosseous repair through bone tunnels. However, current evidence does not identify a single technique that is optimal for all tear patterns. Comparison of suture-anchor fixation with transosseous repair has shown favorable outcomes with both methods, without a clear advantage of either technique (Afifi et al., 2022). Procedure selection should therefore depend on the location and configuration of the tear, tissue quality, the ability to achieve anatomical reattachment, the risk of injury to adjacent structures, and the surgeon's experience. In chronic irreparable tears associated with symptomatic DRUJ instability, reconstruction of the radioulnar ligaments may be considered, but only after excluding degenerative changes and osseous deformities requiring alternative treatment (Atzei et al., 2023).

A similar lack of conclusive evidence applies to postoperative rehabilitation. Reported protocols differ in the duration of immobilization, the extent of elbow motion restriction, the timing of forearm rotation, wrist exercises, and resisted training (McCarron et al., 2023, 2024). This variation may partly reflect differences in repair techniques and the stability achieved during surgery, but it also demonstrates the absence of standardized criteria for progression. Excessively early loading may compromise healing of the attachment, whereas prolonged immobilization increases the risk of stiffness, weakness, and delayed functional recovery. Rehabilitation should therefore be adapted to the type of repair, DRUJ stability, the patient's pain response, and occupational and sporting demands rather than being based on a single time-dependent protocol.

In this context, technologies supporting rehabilitation and outcome monitoring may become increasingly relevant. Standardized measurement of range of motion and grip strength, electronic functional questionnaires, remote monitoring of exercise performance, and objective analysis of load tolerance may facilitate individualized progression and earlier identification of treatment failure. The available literature does not yet establish which technological solutions improve outcomes after TFCC injury. This represents an important area for future research, particularly for patients with limited access to specialized hand therapy.

Assessment of treatment effectiveness should include not only pain, DRUJ stability, range of motion, and grip strength, but also the ability to return to work, sports, and activities of daily living. Most patients may return to their previous level of activity after TFCC repair, although the timing and criteria for return are reported inconsistently (Silber et al., 2023). This has both clinical and social relevance because prolonged impairment of hand function may affect employment, participation in sports, and patient independence. Future studies should therefore use standardized patient-reported outcome measures and clearly defined return-to-

activity criteria rather than limiting the evaluation of treatment effectiveness to anatomical parameters or imaging findings alone.

In summary, contemporary management of traumatic TFCC tears should be based on a functional rather than exclusively morphological understanding of the injury. MRI, MRA, arthroscopy, modern implants, and rehabilitation technologies expand diagnostic and therapeutic possibilities, but their value depends on appropriate patient selection and interpretation of findings in the context of DRUJ stability. The principal gaps in current knowledge concern the standardization of treatment eligibility criteria, direct comparison of repair techniques, the optimal duration and extent of immobilization, rehabilitation progression, and criteria for a safe return to work and sports.

Limitations

This review has several limitations. Owing to its narrative design, the literature search and study selection were not conducted according to a prespecified systematic review protocol. The search was limited to a single bibliographic database and to publications written in English. Consequently, relevant studies indexed exclusively in other databases or published in other languages may have been omitted. Although study screening and data extraction involved multiple reviewers and independent verification, some degree of subjectivity may have influenced the selection, interpretation, and synthesis of the evidence. In addition, no formal, standardized risk-of-bias assessment was performed for the included studies.

Interpretation of the available evidence is further limited by the substantial heterogeneity of the literature. Individual studies included different types of TFCC tears, frequently combined acute and chronic injuries, and used varying definitions of DRUJ instability. They also differed in surgical techniques, immobilization methods, rehabilitation protocols, follow-up duration, and clinical outcome measures. Particularly substantial variability concerned the timing of wrist and forearm mobilization and the introduction of strengthening exercises following foveal TFCC repair.

Most of the evidence concerning conservative and surgical treatment was derived from retrospective studies, small observational studies, and case series. There remains an insufficient number of high-quality randomized or prospective comparative studies directly evaluating conservative versus surgical treatment, individual repair techniques, and rehabilitation strategies. Furthermore, many studies did not provide detailed information regarding DRUJ stability, tissue quality, associated osseous and ligamentous abnormalities, or the criteria used to select patients for particular treatment methods.

These limitations hinder direct comparison of outcomes and the formulation of definitive clinical recommendations. The conclusions of this review should therefore be interpreted as a critical synthesis of contemporary concepts rather than as the basis for a single universal diagnostic and therapeutic algorithm.

Conclusions

Traumatic triangular fibrocartilage complex tears represent a heterogeneous group of conditions whose clinical significance depends not only on the location of the lesion but, more importantly, on its effect on distal radioulnar joint stability and upper-extremity function. Diagnosis should be based on an integrated assessment of the mechanism of injury, clinical presentation, DRUJ stability, and imaging findings. Neither a single clinical test nor an isolated abnormality on MRI or MRA should independently determine eligibility for surgical treatment.

Advances in magnetic resonance imaging, magnetic resonance arthrography, and arthroscopic technologies have improved the ability to assess the TFCC accurately. However, the value of these methods depends on the appropriate interpretation of findings in the context of the patient's symptoms and joint stability. Improved clinical-imaging correlation may reduce the number of unnecessary invasive investigations and surgical procedures performed because of incidental or clinically irrelevant morphological abnormalities.

Conservative treatment remains a justified option in appropriately selected patients with a stable DRUJ and no joint subluxation. Surgical treatment may be required in the presence of persistent symptoms, mechanically unstable tears, or insufficiency of the foveal attachment. Contemporary arthroscopic techniques, including all-inside repair, suture-anchor fixation, and transosseous reconstruction through bone tunnels, enable restoration of TFCC anatomy and stability. However, current evidence does not identify a single technique that is optimal for all tear patterns. Procedure selection should be individualized according to lesion location and chronicity, tissue quality, DRUJ stability, and the patient's functional requirements.

Rehabilitation remains an essential component of treatment, with the aim of protecting the repaired structures while minimizing the risk of stiffness and loss of strength. The absence of standardized protocols indicates the need for individualized management and broader use of objective methods for monitoring range of motion, grip strength, load tolerance, and exercise performance. Remote monitoring technologies and electronic functional assessment tools may support safe rehabilitation progression in the future, although their effectiveness requires further confirmation.

Assessment of treatment outcomes should not be limited to anatomical findings or DRUJ stability. Pain, grip strength, upper-extremity function, and the ability to return to work, sports, and activities of daily living are equally important. Future research should focus on standardizing diagnostic and therapeutic criteria, directly comparing repair techniques, harmonizing rehabilitation protocols, and developing reliable criteria for return to occupational and sporting activities. Contemporary technologies should support more accurate clinical decision-making rather than replace comprehensive functional assessment of the patient.

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