Disorders of the Triangular Fibrocartilage Complex

Lecture by Pr L. Cerezal

Text by chatgpt revised by Pr. B. Vande Berg

Introduction: the TFCC is more than the triangular fibrocartilage

The triangular fibrocartilage complex (TFCC) is one of the most important—and frequently misunderstood—structures of the ulnar wrist. It acts simultaneously as a stabilizer of the distal radioulnar joint (DRUJ), a load-transmitting structure between the carpus and distal ulna, and a stabilizer of the ulnar carpus. TFCC abnormalities are common causes of ulnar-sided wrist pain, but they are also frequently encountered as incidental findings on MRI, particularly with increasing age.

For the radiologist, the challenge is therefore not simply to detect a TFCC tear. The clinically relevant questions are: Where is the lesion? Is it traumatic or degenerative? Are the deep foveal fibers involved? Is the DRUJ unstable? And are there associated abnormalities that better explain the patient's symptoms? Understanding TFCC disorders requires a precise knowledge of anatomy and an appreciation of the limitations of conventional MRI.

TFCC is a three-dimensional complex

The term *triangular fibrocartilage* can misleadingly suggest that the TFCC is simply a central fibrocartilaginous disc. In reality, it consists of several interconnected structures. The central articular disc extends from the sigmoid notch of the radius toward the distal ulna. Its central portion is relatively thin and poorly vascularized. Peripheral components include the dorsal and volar radioulnar ligaments, which play a major role in DRUJ stability.

On the ulnar side, particular attention should be paid to the foveal attachment. Deep fibers insert into the ulnar fovea, while more superficial components extend toward the ulnar styloid. This distinction has major clinical importance because disruption of the deep foveal attachment can result in DRUJ instability.

The TFCC also interacts anatomically and functionally with the ulnolunate and ulnotriquetral ligaments, the extensor carpi ulnaris (ECU) subsheath, and surrounding capsular structures. A useful imaging concept is therefore to divide the TFCC into: central disc – radial attachment – peripheral/styloid attachment – deep foveal attachment.

MRI technique: small structures require small voxels

TFCC imaging is demanding because the relevant structures measure only a few millimeters. High spatial resolution is essential. Dedicated wrist coils and small fields of view should be used. Thin-section coronal proton-density or intermediate-weighted sequences, with and without fat suppression, form the basis of most protocols. Axial images are essential for assessing the DRUJ, ECU tendon and surrounding soft tissues, while sagittal images provide complementary information.

At 3 T, the increased signal-to-noise ratio can be converted into higher spatial resolution and is particularly advantageous for the wrist. However, high field strength does not eliminate the fundamental limitations of MRI. Partial-volume effects, normal variations in TFCC morphology and degeneration can all simulate tears. MR or CT arthrography remains useful in selected patients, particularly when conventional MRI is equivocal and clinical suspicion remains high. Direct arthrography distends the joint and can demonstrate contrast passage through small defects. Nevertheless, neither contrast communication nor increased intradiscal signal should be interpreted without considering lesion location and clinical context.

Central TFCC tears: common, visible—and not always symptomatic

Central tears involve the relatively avascular portion of the articular disc and correspond classically to Palmer type 1A traumatic lesions. On MRI, a tear appears as a linear or focal fluid-signal defect extending through the full thickness of the disc. MR arthrography may demonstrate communication between the radiocarpal and DRUJ compartments. However, central perforations become increasingly common with age and may be asymptomatic. This creates one of the most important interpretative traps in wrist MRI: A TFCC perforation is an imaging finding, not automatically the cause of ulnar-sided wrist pain. The radiologist should therefore assess the entire ulnar wrist for associated degenerative changes, ulnocarpal impaction, lunotriquetral abnormalities, ECU disease and DRUJ pathology.

Peripheral tears: smaller lesion, potentially greater importance

Peripheral ulnar-sided TFCC tears are particularly important because the peripheral TFCC is vascularized and contributes substantially to stability. Palmer type 1B lesions involve the ulnar attachment and may be associated with ulnar styloid fractures.

MRI findings can be subtle. Fluid-sensitive signal, irregularity or discontinuity at the ulnar attachment may suggest a tear. However, distinguishing the different components of the ulnar insertion is crucial. The clinically most important question is often whether the **deep foveal fibers** are intact. A foveal tear can destabilize the DRUJ even when the central disc appears relatively normal. Conversely, a superficial tear near the styloid may produce pain without major instability. For this reason, reports stating simply *"peripheral TFCC tear"* may provide insufficient information for the hand surgeon. Whenever possible, specify whether the lesion involves the superficial styloid attachment, deep foveal attachment, or both.

Radial-sided tears

Radial TFCC tears correspond to Palmer type 1D lesions. The TFCC attaches to the radial sigmoid notch, and disruption may occur following trauma. These tears can be difficult to distinguish from normal high-signal interfaces or partial-volume artifacts. A true tear should demonstrate convincing discontinuity or fluid extending through the attachment in the appropriate clinical context. Associated fractures or ligamentous injuries should be sought because significant wrist trauma rarely respects anatomical boundaries.

Traumatic versus degenerative lesions

The classic Palmer classification separates traumatic type 1 lesions from degenerative type 2 abnormalities. This distinction is useful conceptually, although real-life imaging frequently demonstrates overlap. Degenerative TFCC disease usually begins with thinning and wear of the central disc. Progressive abnormalities may include TFCC perforation, chondral damage of the lunate or ulnar head, lunotriquetral ligament injury and eventually ulnocarpal osteoarthritis.

Ulnar variance matters—but is dynamic

Positive ulnar variance increases load transmission through the TFCC and ulnocarpal compartment and is strongly associated with ulnocarpal impaction. However, ulnar variance should not be regarded as a fixed anatomical number. It varies with forearm rotation and grip. Standardized radiographs therefore remain valuable, and provocative or loaded views may demonstrate dynamic positive ulnar variance that is not apparent on routine neutral imaging. MRI may demonstrate the consequences of abnormal loading: TFCC degeneration, chondral damage and subchondral marrow abnormalities of the lunate or triquetrum.

DRUJ instability: look beyond the TFCC

The TFCC is a major stabilizer of the DRUJ, but instability should not be inferred from a TFCC tear alone. Assessment should include the position of the ulnar head relative to the sigmoid notch, morphology of the DRUJ, integrity of the radioulnar ligaments and foveal TFCC attachment.

CT performed in different positions of forearm rotation can be useful in selected patients with suspected dynamic instability. The ECU subsheath also deserves attention. ECU instability, tenosynovitis or subsheath injury can coexist with TFCC abnormalities and produce very similar ulnar-sided symptoms.

The radiologist should therefore resist the temptation to stop searching after finding a TFCC lesion.

Ulnar styloid fractures: location is important

Ulnar styloid fractures are common after wrist trauma, but their significance depends partly on their location. A small styloid-tip fracture may have little effect on DRUJ stability. A fracture involving the styloid base and foveal region is potentially more important because of the attachment of the deep TFCC components. In chronic cases, an ulnar styloid nonunion may coexist with TFCC abnormalities. The key question is again not simply whether a nonunion exists, but whether the stabilizing foveal attachment has been compromised. CT and MRI are highly complementary in this setting: CT defines the bone abnormality, while MRI evaluates the TFCC and associated soft tissues.

Beware of asymptomatic abnormalities

One of the most important lessons in TFCC imaging is that structural abnormalities increase with age. Degeneration, thinning and even perforation may be present without corresponding symptoms. Reporting every signal abnormality as a clinically significant tear risks overdiagnosis. This is particularly relevant in older patients in whom degenerative changes may involve several structures simultaneously. The radiologist should therefore describe abnormalities precisely while avoiding unjustified causal conclusions.

A practical reading strategy

A systematic approach can make TFCC interpretation considerably easier.

- First, evaluate the central disc for thickness, signal and perforation.
- Second, follow the radial attachment and then the ulnar attachment, specifically separating superficial styloid fibers from the deep foveal component.
- Third, assess the DRUJ and look for evidence of instability or associated arthropathy.
- Fourth, examine the ECU tendon and subsheath.
- Fifth, evaluate ulnar variance and search for signs of ulnocarpal impaction, particularly cartilage loss and subchondral marrow abnormalities of the lunate and triquetrum.
- Finally, assess the lunotriquetral ligament and the remainder of the wrist.

Conclusion

TFCC disorders are common, but their interpretation requires more than detecting high signal within the triangular fibrocartilage. The central questions for the radiologist are where the lesion is located, whether it is traumatic or degenerative, whether the deep foveal attachment is involved, and whether associated abnormalities suggest instability or ulnocarpal overload.

Central perforations may be conspicuous but incidental. Small peripheral foveal lesions may be much less obvious yet considerably more important clinically. The most useful report therefore moves beyond the generic diagnosis of a *"TFCC tear"*.

A good report should tell the clinician which component is abnormal, whether the stabilizing attachments are preserved, and what other abnormalities of the ulnar wrist accompany the lesion. Ultimately, TFCC imaging becomes easier when the radiologist stops looking at a triangle and starts looking at a three-dimensional stabilizing complex connecting the radius, ulna and carpus.