Arthroscopic-Assisted Triangular Fibrocartilage Complex Reconstruction

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KEYWORDS

• Triangular fibrocartilage complex • Distal radioulnar joint • DRUJ instability • TFCC tear
• TFCC reconstruction • Wrist arthroscopy

KEY POINTS

- The triangular fibrocartilage complex (TFCC) is the primary stabilizer of the distal radioulnar joint, comprising the articular disc, the meniscus homologue, the volar and dorsal distal radioulnar ligaments, the subsheath of the extensor carpi ulnaris, the ulnar capsule, and the ulnolunate and ulnotriquetral ligaments.
- The volar and dorsal radioulnar ligaments have an important stabilizing effect in forearm rotation, with an isometric point of insertion in the fovea.
- In irreparable TFCC tears, anatomic TFCC reconstruction is the recommended treatment to restore stability of the distal radioulnar joint.
- The surgical technique of an arthroscopic-assisted approach in anatomic TFCC reconstruction is described. Soft tissue dissection is minimized and the joint capsule is not violated.
- Outcomes of this approach are comparable to the conventional open technique and may be superior in restoring range of motion.

RELEVANT ANATOMY AND BIOMECHANICS OF THE TRIANGULAR FIBROCARTILAGE COMPLEX

A solid understanding of the anatomy and biomechanics of the triangular fibrocartilage complex (TFCC) is crucial for undertaking its repair or reconstruction. The TFCC is a composite structure of ligamentous, fibrous, and fibrocartilaginous components that are blended as a homogeneous complex and function as a unit to stabilize the distal radioulnar joint (DRUJ), transmit load from the ulnar carpus to the ulna, and allow smooth wrist motion and forearm rotation.[1] Our current understanding of its functional anatomy is due largely to the work of Palmer and Werner in 1981[2] and the body of anatomic and biomechanical studies that followed. The TFCC is the primary intrinsic stabilizer of the DRUJ,[3] which is an inherently incongruent joint and relies mainly on soft tissue stabilizers. Division of the TFCC alone has been shown to result in dorsal DRUJ dislocation in neutral, pronation, and supination and volar dislocation in neutral and supination, in the presence of intact DRUJ capsule and pronator quadratus.[2] The TFCC consists of the articular disc, the meniscus homologue, the volar and dorsal distal radioulnar ligaments, the subsheath of the extensor carpi ulnaris, the ulnar capsule, and the ulnolunate and ulnotriquetral ligaments.[2,4] In particular, within the TFCC, the

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important stabilizing effect of the volar and dorsal radioulnar ligaments during forearm rotation have been demonstrated by multiple studies.[4–7] In pronation, the superficial dorsal and deep palmar fibers of the distal radioulnar ligaments become taut, whereas in supination, the superficial palmar and deep dorsal ligaments become taut.[5,8] On the other hand, the articular disc proper has a less important role in stabilizing the DRUJ and can be excised up to two-thirds without significant kinematic change.[9] The radioulnar ligaments are inserted into the fovea and the ulnar styloid, with the foveal insertion having the major effect on stability.[10] Nakamura and Yabe[11] described the distal portion of the TFCC as a hammocklike structure that supports the ulnar carpus, with a proximal portion being the radioulnar ligaments anchoring to the fovea. The hammock thus becomes unsteady once the anchor is broken.

The vascularity of the TFCC shows similarity to that of the meniscus of the knee. Thiru-Pathi and colleagues[12] showed that only the outer 15% to 20% of the articular disc is vascular, whereas Bednar and colleagues[13] reported that the vascularity of the TFCC is limited to the peripheral 10% to 40%. The feeding vessels are branches from the ulnar and anterior interosseous arteries. The radial and central portion of the TFCC receives nutritional support from synovial fluid. This pattern of vascularity dictates that only the periphery has predictable healing potential from surgical repair, whereas that of central tears is scarce.

EPIDEMIOLOGY AND PATHOMECHANISM OF TRIANGULAR FIBROCARTILAGE COMPLEX INJURY

Injury of the TFCC was cited as the most common cause of ulnar-sided wrist pain.[14,15] A systematic review reported a prevalence of TFCC abnormalities in symptomatic wrists ranging from 39% to 70% in patients between 50 and 69 years old.[16] Another study showed that up to 78% of distal radius fractures had associated TFCC injuries detected by arthroscopy in patients 20 to 60 years old.[17] The mechanism of injury commonly involves abrupt forceful rotation, or loading and distraction injury to the ulnar wrist and forearm.[17] Loading of the wrist in extreme extension and pronation or supination was the most common mechanism reported in a series and was verified in 2 cadavers by Coleman in 1960.[18,19] This frequently occurs in a fall on the outstretched upper extremity, particularly when falling to the side or backward. Patients with ulnar plus variance may also be more prone to injury due to the thinner TFCC.[20] Moritomo and colleagues[21] in 2010 also noted that wrist hyperextension with forearm rotation was the most common injury mechanism. They further correlated the surgical findings of TFCC tear with mechanism of injury and suggested that forced wrist extension resulted in excessive traction of the ulnocapitate ligament, which in turn avulses the deep palmar radioulnar ligament from its foveal insertion. The second mechanism of injury was forceful rotation, in which hyperpronation was suggested to result in first an injury of the superficial dorsal radioulnar ligament and then the foveal insertion. Degenerative tears, which commonly result in attrition and perforation of the TFCC, were suggested to be caused by chronic repetitive loading of the wrist,[18] particularly in ulnar deviation and pronation.

CLINICAL ASSESSMENT OF TRIANGULAR FIBROCARTILAGE COMPLEX TEAR

The mechanism of injury, as described previously, is a useful clue to the diagnosis. There may be a "pop" sound with TFCC injury. Symptoms include ulnar wrist pain on rotation with or without loading, decreased range of motion, instability, weakness, and joint clunk. Chronicity and the presence of preexisting symptoms are noted. Physical signs are important to locate the site(s) of injury, help determine the type of lesion within the TFCC, and judge the extent of DRUJ instability. These include prominence of the ulnar head, and local tenderness corresponding to specific lesions. Common tender sites include the dorsal TFCC, the ulnar snuff box, or foveal area,[22] which is the interval between the ulnar head, triquetrum, flexor carpi ulnaris, and extensor carpi ulnaris tendons; the DRUJ dorsal capsule, lunate, triquetrum, and lunate triquetral ligament. Instability is elicited by provocative tests. Passive pronosupination of the forearm will be painful, which may limit the range of motion in peripheral TFCC tear. The DRUJ ballottement test is done in neutral, supination, and pronation. In the neutral position, there is normally up to 5 mm of dorso-volar translation of the DRUJ due to the inherent joint configuration. It is at the most stable locked position in maximal pronation and supination, and any translation should be regarded as abnormal. Furthermore, in full pronation, pain elicited by dorsal push of the ulnar head relative to the radius indicates tear of the deep palmar radioulnar ligament; whereas in full supination, pain elicited by volar push of the ulnar head indicates tear of the deep dorsal radioulnar ligament. The classic piano key sign may be positive in overt instability of the DRUJ.[23] The ulnocarpal ligament stress test is performed with the forearm in neutral rotation and the wrist in radial deviation, in which the ulnar head is balloted in