Carpal Ligament Anatomy and Biomechanics

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KEYWORDS

• Anatomy • Ligaments • Wrist • Carpal

KEY POINTS

- A fundamental understanding of the ligamentous anatomy of the wrist is critical for any physician attempting to treat carpal instability.
- The scapholunate interosseous (SLIO) ligament is the main stabilizer of the scapholunate articulation, providing a flexion moment on the lunate.
- The lunotriquetral interosseous (LTIO) ligament is the main stabilizer of the lunotriquetral articulation, providing an extension moment on the lunate.
- The combined actions of the SLIO and LTIO ligamentous complexes torque-suspend the lunate between the scaphoid and triquetrum.
- Other ligaments may act as secondary stabilizers, whose disruption may increase carpal instability.

INTRODUCTION: LIGAMENTOUS ANATOMY

The anatomy of the wrist was first described in Weitbrecht's illustrations in 1742. Scores of anatomic and kinematic studies have identified the attachments and functions of these ligaments.[1] However, the lack of consistency in describing these ligaments presents a challenge for physicians attempting to understand the ligamentous anatomy of the wrist joint.[2] In addition, the terminology used to describe the ligaments has only recently been standardized.[3]

The bones of the distal carpal row have tendinous attachments but little intercarpal motion as a result of ligamentous and bony constraint. Conversely, the scaphoid, lunate, and triquetrum, which make up the proximal carpal row, have been termed as intercalated segment because of their lack of direct tendinous attachments. The bones of the proximal carpal row move relative to one another by muscular forces extrinsic to the proximal row itself.

The differences between ligaments of the wrist are seen on a histologic scale as well. Hagert and colleagues[4] found that the radial wrist ligaments consisted of densely packed collagen bundles, whereas the dorsal wrist ligament complex contained an abundance of nerves and mechanoreceptors. Thus some ligaments may be more important in providing stability to the carpus, whereas others may serve more proprioceptive functions.

Wrist ligaments can also be described as intracapsular or intra-articular based on their histology. Both types of ligaments are composed of fascicles of densely packed, highly organized parallel collagen fibers. These fascicles are surrounded by perifasicular spaces, which are composed of loose connective tissue containing neurovascular triads. Intra-articular ligaments are covered

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entirely by synovial strata, whereas intracapsular ligaments have the synovial stratum only on their deep or joint surface.[5]

This review summarizes the ligamentous attachments to the carpal bones and how they affect normal carpal bone mechanics.

EXTRINSIC CARPAL LIGAMENTS

Extrinsic carpal ligaments connect the forearm bones with the carpus. Because there are no dorsal ligaments between the ulna and carpus, these extrinsic carpal ligaments are divided into 3 groups: palmar radiocarpal ligaments, palmar ulnocarpal ligaments, and dorsal radiocarpal (DRC) ligaments (Fig. 1).

In a biomechanical study, Katz and colleagues[6] demonstrated that the palmar capsuloligamentous structures play a more substantial role in preventing both dorsal and palmar carpal translation than the dorsal structures. In their study, the palmar capsuloligamentous structures provided 61% of the restraint to dorsal translation of the carpus and 48% of the restraint to palmar translation.

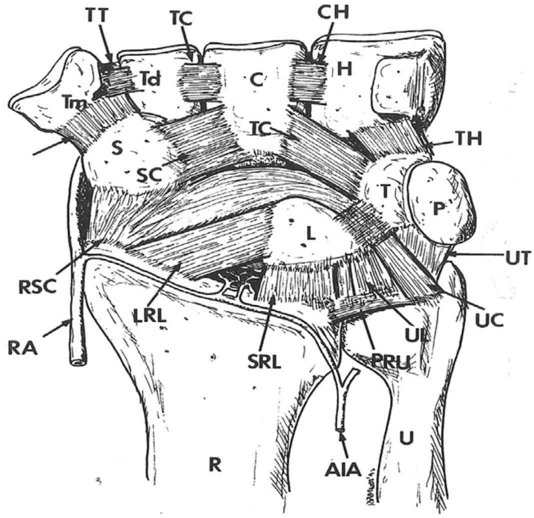

Fig. 2. The palmar carpal ligaments from a palmar perspective. Ligaments: CH, capitohamate; LRL, long radiolunate ligament; PRU, palmar radioulnar; RA, radial artery; AIA, anterior interosseous artery; SC, scaphocapitate; TC, trapezocapitate; TC, triquetrocapitate; TH, triquetrohamate; TT, trapeziotrapezoid; UC, ulnocapitate; UL, ulnolunate; UT, ulnotriquetral. Bones: C, capitate; H, hamate; L, lunate; P, pisiform; R, radius; S, scaphoid; T, triquetrum; Td, trapezoid; Tm, trapezium; U, ulnar. (*From* Berger RA. The ligaments of the wrist. A current overview of anatomy with considerations of their potential functions. Hand Clin 1997;13(1):68; with permission.)

Palmar Radiocarpal Ligaments

The radioscaphocapitate (RSC) ligament is the most radial of the palmar radial carpal ligaments, originating from the palmar surface of the radial styloid process (Fig. 2). According to Berger and Landsmeer,[7] there are 3 major components to this ligament based on the location of insertion. The first component, the so-called radial collateral ligament, is composed of fibers originating from the most distal aspect of the radial styloid process, which course distally to the radiopalmar surface of the waist of the scaphoid. The remaining fibers of the RSC ligament course distally and ulnarly toward the capitate with the radialmost of these fibers inserting into the proximal surface of the distal pole of the scaphoid forming the radioscaphoid component. Finally, the fibers of the radiocapitate component, the largest component, interdigitate with fibers of the ulnocapitate (UC) ligament from the triangular fibrocartilage complex (TFCC) just palmar to the head of the capitate.[7] This ligament serves to constrain radiocarpal pronation and ulnocarpal translocation.[8,9] Fibers of the RSC interdigitate with the

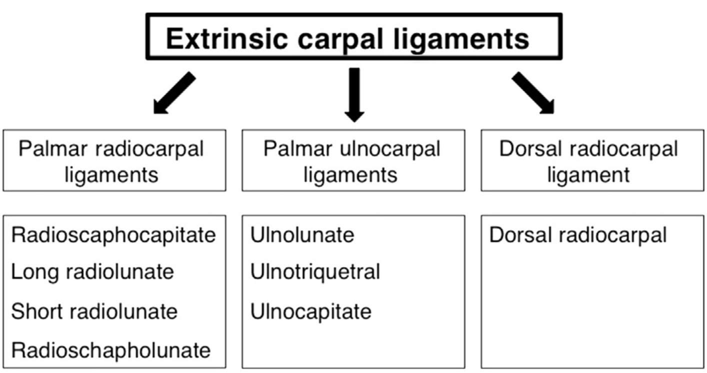

Fig. 1. Extrinsic carpal ligaments.