Journal of Ultrasound (2012) 15, 267—272

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High-resolution ultrasound of the extrinsic carpal ligaments☆

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KEYWORDS
Ultrasound;
Extrinsic carpal ligaments;
Rheumatoid arthritis;
Wrist;
Wrist instability.

Abstract Thanks to its intrinsic high spatial resolution, ultrasound is an ideal imaging modality for examining very thin, superficial structures, and this makes it very helpful in the evaluation of extrinsic carpal ligaments. These structures, which arise from the radius and ulna and insert on the carpal bones, are extremely important for wrist stability. Previous studies have assessed the use of ultrasound to study the extrinsic carpal ligaments in cadavers, healthy asymptomatic subjects, and patients with rheumatoid arthritis. In the present report, we review the normal anatomy, biomechanics, and ultrasound appearance of these ligaments.

Sommario L'ecografia è una metodica di imaging che, grazie alla sua elevata risoluzione spaziale, appare ideale nella valutazione di strutture superficiali anche molto sottili. Questa ca-ratteristica la rende una metodica estremamente valida nella valutazione dei legamenti estrinseci del carpo. Tali strutture originano dal radio e dall'ulna e si inseriscono sulle ossa della filiera carpale dando così un contributo fondamentale alla stabilità del carpo. Solo due studi in letteratura hanno descritto l'utilizzo dell'ecografia nella valutazione dei legamenti estrinseci del carpo su cadavere e in pazienti sani asintomatici. Un terzo studio ha invece decritto l'aspetto di tali legamenti in pazienti affetti da artrite reumatoide. Nel presente studio è riportata una revisione dell'anatomia normale, della biomeccanica, e dell'aspetto ecografico dei legamenti estrinseci del carpo.

☆ Best poster presented at the XXIII Congress of the SIUMB (2011) in Rome, Italy.

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http://dx.doi.org/10.1016/j.jus.2012.09.004

Introduction

The concept of wrist stability has been widely discussed in recent years. It is the result of complex interaction between bony structures and the intrinsic and extrinsic ligaments of the wrist [1].

Traumatic and degenerative lesions of the intrinsic carpal ligaments have been well characterized with several imaging modalities, including ultrasound, computed tomography (CT), magnetic resonance (MR), and CT- and MR-arthrography, which involve the intrarticular injection of contrast agents [2—6].

Much has been written about the anatomy and function of the extrinsic ligaments of the wrist. Mayfield et al. [7] described the importance in wrist instability of the volar radiocarpal ligaments. Other studies have confirmed the importance of the dorsal extrinsic ligaments [2—4]. The role of the latter ligaments as secondary wrist stabilizers is well established. The extrinsic ligaments have also been evaluated with a variety of imaging modalities [2—4,8—11], and ultrasonography has proved to be a valuable tool for this purpose in normal subjects and in patients with rheumatoid arthritis (RA) [8—11]. This article provides a review of the literature regarding ultrasound evaluation of the extrinsic carpal ligaments in individuals of both types.

Normal anatomy

The extrinsic ligaments originate from the carpal bones and pass out of the wrist to insert onto the radius or ulna. These features make them important for wrist stability [10,12]. The extrinsic ligaments are subdivided into the dorsal ligaments, the volar (or palmar) ligaments, and the collateral ligaments. The extrinsic ligaments located on the palmar side of the wrist are the radioscaphocapitate (RSC), the radiolunotriquetral (RLT), the radioscapholunate (RSL), the palmar ulnolunate (pUL), and the palmar ulnotriquetral (pUT) ligaments. Those on the dorsal aspect include the radiotriquetral (dRT) and the ulnotriquetral (dUT) ligaments. The collateral ligaments include the radial collateral (RC) and the ulnar collateral (UC).

All of the extrinsic ligaments are intracapsular but extrasynovial: their outer surface is covered by the fibrous portion of the capsule, and their deep surface is covered by synovial membrane [13].

Ultrasound anatomy of the extrinsic carpal ligaments in normal subjects

The normal ultrasound anatomy of the extrinsic carpal ligaments has been documented in two previous studies [8,9], which yielded comparable results in terms of the depiction of these structures. Tables 1 and 2 show the results of the studies regarding ligament thickness and ligament visualization, respectively. The other wrist ligaments are more difficult to visualize, particularly the ulnar collateral and the radiolunate ligaments. Owing to their small size and irregular course relative to the skin surface, they were never identified in either of the studies cited above.

Palmar ligaments

The RSC and RLT ligaments can be easily identified with the aid of bony landmarks. The transducer should initially be moved along the longitudinal axis of the scaphoid bone (RSC ligament) or that of the lunate bone (RLT ligament) and then slowly rotated to achieve a plane parallel to the long axis of the ligament [8,9].

To identify the RSL, UL, and UT ligaments, the patient's wrist should be hyperextended with a cylindrical support (e.g., container of coupling gel) beneath the dorsal aspect. The transducer should be positioned longitudinally over the ulnocarpal joint and moved slowly from the medial to the lateral side to visualize the UT, the UL, and the RSL ligaments [8,9]. The triquetral and lunate bones are helpful landmarks for identifying the expected locations of the UT and UL ligaments, respectively.

The *RSC ligament* arises from the radial aspect of the wrist and extends obliquely to the palmar side of the distal scaphoid pole, where it attaches with a fibrous band. Distally, it is attached to the capitate via a broad fibrous insertion (Fig. 1). The *RLT ligament* arises from the palmar aspect of the styloid process of the radius, passes over the scaphoid bone, and inserts onto the lunate. Distally, it runs along the radial side of the pisotriquetral joint and inserts onto the palmar aspect of the triquetrum. The *RSL ligament* is firmly attached to the deep aspect of the radiolunotriquetral ligament and cannot be differentiated from it on ultrasound. This ligament has been identified and successfully evaluated with MR arthrography [6]. The *palmar ulnolunate (pUL) ligament* originates from the ulna and the palmar radioulnar ligament, runs parallel to the ulnotriquetral ligament, and inserts onto the palmar aspect of the lunate, together with the RLT ligament (Fig. 2). The *palmar ulnotriquetral (pUT) ligament* arises proximally onto the palmar side of the ulna and extends perpendicularly to its insertion on the palmar aspect of the triquetrum.

Dorsal ligaments

To identify the RT and UT ligaments, the wrist should be hyperflexed with the palmar aspect resting on a cylindrical support. The scan commences in the transverse plane over the dorsal radial tubercle (i.e., RT ligament). The UT ligament can be visualized with the transducer positioned longitudinally over the ulnocarpal joint, above the triangular fibrocartilage complex [14,15]. The *dorsal radiotriquetral (dRT) ligament* originates from the dorsal side of the distal radius, passes over the lunate, and inserts on the dorsal side of the triquetrum. The dorsal ulnotriquetral (*dUT*) *ligament* originates from the ulna and extends to the ulnar aspect of the triquetrum, where it shares an insertion with the dRT ligament.

Collateral ligaments

To assess the RC ligament, the patient's wrist should be placed in ulnar deviation, with the ulnar aspect of the wrist lying on a cylindrical support. To evaluate the UC ligament, the patient's wrist is placed in a pronated position, in radial