High resolution sonography of the dorsal radiocarpal and intercarpal ligaments: findings in healthy subjects with anatomic correlation to cadaveric wrists

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Among these injuries, scapholunate dissociation is the most frequent cause of wrist instability and its arthrogenous course can have serious functional consequences (1). According to the Mayfield and Watson theory, dorsal scapholunate ligament tears play a central role in this instability (2).

In fact, it has been shown that isolated sectioning of the scapholunate ligament, even complete sectioning, does not result in any signs of scapholunate instability (3): long term follow up of patients presenting with isolated rupture of this ligament confirms the absence of an arthrotic course (4). Extrinsic ligament injuries must be associated with this rupture to cause mechanical decoupling of the scaphoid and lunate. Although there is no complete consensus, recent studies have emphasized the role of the dorsal radiocarpal and intercarpal capsular ligaments in these injuries (3, 5-7). A schema of the anatomy of these extrinsic ligaments is presented in figure 1. The small size, the weak spontaneous contrast on imaging and the three dimensional structure of the ligaments makes them a challenge for imaging.

CT arthrography, MRI and more recently MR arthrography have been evaluated to
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study these ligaments. Although MR arthrography is the only existing technique with diagnostic results similar to arthrography (7), it is an invasive, costly test which is not readily available, with a risk of infection. Thanks to recent technical progress in superficial spatial resolution, ultrasound is playing an increasingly important role in the exploration of ligament anatomy. It has the advantage of being a non-invasive technique which is well accepted, rapid, moderately priced, allowing dynamic and specific exploration of the painful area (8).

Within this context, the goal of this study was to evaluate the results of ultrasound in the study of normal dorsal radiocarpal and intercarpal ligaments of the wrist, based on the study of two cadaveric wrists and 40 healthy volunteer wrists.

Material and methods

Cadaveric studies

For the anatomical cadaveric study, the dorsal right and left wrists of a recently frozen cadaver of a 92 year old woman were studied. The dissections were performed by a surgeon specialised in hand surgery. The dissection was performed plane by plane and each anatomical structure was identified. The dorsal radiocarpal and intercarpal ligaments are identified with traction sutures.

Study of healthy volunteers

Forty wrists of ten women and ten men healthy volunteers were prospectively studied on ultrasound. These volunteers were an average of 28.9 years old with a range of 21-37 years old. Ultrasounds were performed with the most recent ultrasound device installed in 2007 (IU 22 Philips, Seattle, USA), with a high frequency linear 17 Megahertz probe. The machine was adjusted for superficial imaging. The patient was seated with the elbow resting and flexed, and the forearm along the axis of the third metacarpal in a neutral position. The wrist was studied from a slightly flexed dorsal approach so the capsular dorsal ligaments were tensed.

The probe was initially placed in the transverse position. First Lister’s tubercle was identified. The ultrasound operator then moved the probe distally to the scapholunate space. The distal scapholunate ligament was visualised as a compact hyper-echoic fibrillar structure. A second distal movement provided an axial view of the dorsal intercarpal ligament. Finally the longest part of the radiocarpal ligament was explored in an axial oblique view by...
proximal rotation of the probe by approximately 40°, keeping the triquetrum as the fixed point, (fig. 2).

Criteria for analysis of the ligaments

The criteria noted were the visibility and the thickness of the ligaments at their mid-points, as well as at the osseous insertion sites. The visibility of each portion of the ligament was measured and classified as completely visible (100 %), partially visible (>50 %) if the insertion sites were partially exposed, insufficiently visible (<50 %) and not visible.

For the descriptive analysis, the thickness of the portions of the ligament was described according to the average, standard deviation, minimum and maximum thicknesses. The visibility of ligaments was also described and percentage of visibility determined (0 %, < 50 %, > 50 % and 100 %). A comparative analysis was made using the Wilcoxon test for paired samples to compare thicknesses with the dominant hand and the Mann Whitney test to compare differences by sex.

Results

Cadaveric study (fig. 3)

The dorsal radiocarpal and intercarpal ligaments make a “V” that extends transversely across the dorsal part of the wrist. The two branches of this “V” meet on the triquetrum and leave a dorsal mediocarpal space free in the center. These ligaments are capsular because they are included in the joint capsule. The dorsal radiocarpal ligament, which is also called the dorsal radiotriquetral ligament is an extrinsic ligament because its bone insertion site is extracarpal. It includes a triangular ligamentous band with a radial base, facing downwards and inwards towards the triquetrum. It inserts largely outside the radiodorsal edge of Lister’s tubercle and terminates in the dorsal triquetral tubercle. During extension (reclination) the deep insertions of the dorsal lunate can be seen. This ligament includes a single radiocarpal bundle; this structure was symmetrical in the two wrists studied. Morphological measurements were 20mm long and 10mm wide.

The dorsal intercarpal ligament, which is also called the dorsal scaphotriquetral ligament is an internal ligament because it joins two carpal bones. This ligament crosses the carpal bones transversely. It inserts on the dorsal part of the scaphoid neck and tubercle terminating on the triquetrum where its fibres connect to the radiocarpal ligament. Along its course, it inserts onto the dorsal scapholunate ligament. This position was symmetrical in both wrists studied with a ligament formed by three thin, distinct bundles. An additional trapezotriquetral band was present on both wrists. The measurements were 40mm long and 7mm wide.

Study of healthy subjects (fig. 4)

The radiocarpal and intercarpal ligaments had the same appearance on ultrasound: thin, linear, fibrillar, hyperechoic, and extending towards their respective bone insertion sites. There were no anatomical variants on ultrasound in our series. The descriptive analysis of results showed comparable ligament thicknesses, which were thicker at the insertion sites, and thinner in the mid-portion. The mid-portions of the ligaments were visible in all healthy volunteers. The triquetral and the scaphoid insertions were completely visible in 90% of cases. The radial insertion of the radiocarpal ligament was completely visible in 77.5% of cases. Table I summarizes the main results of this study. The results of the comparative statistical analysis did not show any significant difference between the thickness of ligaments in the dominant and non-dominant hands (p = 0.07). On the other hand, there were significant statistical differences in thicknesses according to sex; men’s ligaments were thicker than women’s for all measured variables (p = 0.04).

Discussion

Few studies have been published on the analysis of wrist ligaments by ultrasound. Most of these studies concern the scapholunate ligament (9,10). To our knowledge only two studies have reported the value of ultrasound in the analysis of extrinsic and intrinsic ligaments of the joint capsule (11,12) (11). Our study shows the importance of high frequency ultrasound in the analysis of these anatomical structures. Our results show that the middle portion of the extrinsic dorsal ligaments are always visible on ultrasound and are completely or
partially visible in most cases at their bone insertion sites; the depth of these structures and the many bony interfaces sometimes make complete visualisation of the ligament difficult.

As previously shown in the study of thirty wrists in fifteen healthy volunteers by Boutry, et al. (11), the middle portion of the extrinsic dorsal ligaments is usually visible: the radiocarpal ligament was completely visible in 93 % of cases, and the intercarpal ligament in 89 % of cases. More recently, the study of thirty-six wrists in eighteen healthy subjects by Lacelli, et al. (12), reported that 96 % of the radiocarpal ligaments were visible. These two studies did not explore the bone insertion site, which may be the site of ligament tears. Although the same type of ultrasound device was used in the two studies mentioned above and ours, the visualisation percentages were higher in our study and in Lacelli et al.’s. The thickness of the middle portion of the two ligaments is fairly constant from one study to another: approximately 1.5 mm (7, 11). On the other hand, our measurements of the insertion sites are smaller than those reported in the only previous study on this subject with MR arthrography (7).

There are several possible explanations for these discrepancies: MR arthrography measurements were performed on cadavers. These ligaments may be modified compared to young, healthy volunteers. MR arthrography measurements may include the sum of the capsule and the ligament, thus increasing measurement results. The anatomical variants are easier to visualize on MR arthrography, while in certain cases only one ligament bundle was measured on ultrasound. The patient’s position affect the results? Is there capsular distension during MR arthrography? Are measurements overestimated because of the effect of magnetic susceptibility? Other studies are needed to clarify these different points.

Our study has certain limits which must be mentioned.

By voluntarily limiting our study to young subjects with no history of trauma, we cannot draw conclusions about possible morphological changes in the ligaments over time. Moreover there was a significant difference in the age of the dissected cadaver and the healthy population studied by ultrasound. Nevertheless, none of the studies in the literature have suggested that there are degenerative capsular ligament lesions, unlike the results found on the scapholunate ligament (4).

The interobserver variability was not evaluated because only one ultrasound operator performed all the examinations. None of the anatomical variants described in other studies were found in our study. A study with a larger number of subjects might have provided visualisation of these variants.

The correlation with another imaging method (MR arthroscopy or CT arthroscopy) could not be performed in healthy subjects because of the invasive nature of these techniques.

### Conclusion

This study showed the results of the assessment of normal dorsal radiocarpal and intercarpal ligaments with ultrasound. Good knowledge of anatomy, a high frequency probe and a standardized examination protocol are necessary to obtain reliable results.
References