Carpal ligaments evaluation with ultrasound and MRI: A pictorial review

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Learning objectives

In this poster we illustrate techniques used to image the carpal ligaments, especially the ulnar collateral ligament of the metacarpophalangeal joint of the thumb, the scapho-lunate and the lunato-triquetral ligament, using ultrasound and magnetic resonance imaging.

We demonstrate the appearances of the different carpal ligaments and show important pathologies.

Background

Evaluation of the carpal ligaments, especially scapho-lunate and lunato-triquetral and the ulnar collateral ligament of the metacarpophalangeal joint of the thumb is often required.

While magnetic resonance imaging (MRI) is an accurate modality for the evaluation of the central disc of the triangular fibrocartilage complex (TFCC), the accuracy for imaging the scapho-lunate (SL) and lunato-triquetral (LT) ligament has been somewhat less, with the literature reporting sensitivity of up to 86% and specificity of up to 100% for the SL ligament and sensitivity of up to only 56% and specificity of up to 100% for the LT ligament. However high resolution 3D MRI sequences can considerably improve diagnostic ability.

The ulnar collateral ligament (UCL) of the metacarpophalangeal joint of the thumb can be imaged accurately both with MRI, especially if high resolution 3D sequences are used, and ultrasound (US). In our institution we prefer US imaging of the UCL because of the capability of US to image dynamic processes.

Other carpal ligaments are less commonly imaged. We image most of those with MRI, again using high resolution 3D sequences.

Imaging findings OR Procedure details

For accurate imaging of the carpal ligaments anatomical knowledge about their insertion and course is necessary.

The ligaments can be classified in functional-topographic manner:
• Interosseous ligaments, which run directly between two carpal bones
• Palmar proximal V, which run from the radius and ulna to the lunate in the shape of an inverted V
• Palmar distal V, which run from radius and triquetrum to the capitate in the shape of an inverted V
• Dorsal V, which run from radius and scaphoid to the triquetrum in the shape of a horizontal V

The **interosseous ligaments** are:

• Radioscapholunate ligament (RSL)
• Scapholunate ligament (SL)
• Lunatotriquetral ligament (LT)
• Capitohamate ligament (CH)

SL, LT and CH ligaments are usually easily demonstrated on MRI, while the RSL ligament can be difficult to visualise.

The **RSL ligament** stabilises the proximal pole of the scaphoid in relation to the radius, but also functions as a neurovascular bundle, with branches of the anterior interosseous artery and nerve running within it, which both supply the proximal pole of the scaphoid as well as the SL ligament. The RSL ligament originated from the palmar side of the distal radius at the level of the interfacet prominence and runs to the palmar and middle parts of the SL ligament.

The **SL ligament** is a very important one. It holds scaphoid and lunate together and is the most important stabiliser of the carpus. It runs in a U-shape between the proximal scaphoid and lunate. It shows a certain elasticity and therefore allows small movements between scaphoid and lunate. It consists of three different parts, which can be differentiated histologically and have different biomechanical functions.

The palmar part runs in a coronal plane. It consists of strong collagen fibres which are imbedded in loose connective tissue and insert directly on the cortical bone. This segment is slightly longer than the other two segments. It is relatively well vascularised.

The middle segment runs in an axial plane and is a thin fibrocartilaginous membrane, which does not have any stabilising function. It runs between the hyaline articular cartilage of scaphoid and lunate. It often shows degenerative changes, which regularly occur from the 4th decade of life as a pin hole defect and are usually asymptomatic.

The dorsal segment again runs in a coronal plane and consists of thick, densely packed collagenous fibres, which mainly insert into the cortical bone via Sharpey fibres. This segment is fairly short and is the main stabilisor between scaphoid and
lunate. Traumatic, or less commonly degenerative, disruption of this segment leads to a rotational subluxation of the scaphoid and scapho-lunate dissociation.

The **LT ligament** is configured similarly to the SL ligament, but thinner. It consists of a dorsal and palmar segment, which run in a coronal plane between the lunate and triquetrum. Similar to the SL ligament there is also a thin, membranous middle segment, which does not have any stabilising function and often shows degenerative perforation.

The **CH ligament** is a very stable and thick structure, which can easily be seen on MRI.

There are several other ligaments between the bones of the distal carpal row, however they tend not to have much clinical significance.

The **palmar-proximal V** consist of:

- Radiolunotriquetral ligament (RLT)
- Ulnotriquetral ligament (UT)
- Ulnolunate ligament (UL)
- Ulnocarpal disc (TFC) (not a ligament as such)

All of those can easily be visualised on MRI.

The **RLT ligament** forms the radial part of the proximal V. It is the strongest ligament of the carpus. It originates broadly based on the from the distal radius on the palmar side. It first runs to the lunate, where it attaches with a few fibres, and continues in the same direction to the triquetrum. Together with its dorsal "twin", the dorsal radiotriquetral ligament, it stops the carpus from sliding off the articular surface of the distal radius, which shows about 25°of ulnar angulation.

The ulnar part of the proximal V consists of the **UL** and **UT ligaments**. They are palmar reinforcements of the TFCC. They originate from the palmar radioulnar ligament at the level of the ulnar styloid and run lunatum and triquetrum. Often some fibres also insert into the LT ligament. They are important stabilisers of the ulnar side of the carpus.

Part of the proximal V is also the **TFC**, which however is not a ligament as such.

The ligaments of the **palmar distal V** are:

- Radioscaphocapitate ligament (RSC)
• Scaphocapitate ligament (SC)
• Triquetrocaphitoscaphoid ligament (TCS)
• Scaphotrapeziotrapezoid ligament (STT)

The RSC and the TCS ligament can usually be easily demonstrated on MRI, the other two ligaments are more difficult to see.

The radial side of the distal V consists of the RSC and the SC ligaments. The RSC ligament originates broadly based from the radial styloid and runs obliquely over the scaphoid waist and further to the middle part of the capitate. On the distal half of its course it is accompanied by the SC ligament, which connects the middle thirds of scaphoid and capitate. These ligaments prevent the capitate from slipping to the ulnar side. In a proximal scaphoid fracture the RSC ligament can slip into the fracture line and lead to a non-union.

The STT ligament is considered part of the distal V. It consists of palmar and dorsal intrinsic ligaments that connect the scaphoid with the trapezium and trapezoid and only allows very moderate mobility between these three bones.

The TCS ligament forms the ulnar side of the distal V. It runs in an arcuate manner in the depth of the carpal tunnel. It originates from the palmar side of the triquetrum, runs over the tip of the hamate and the neck of the capitate and inserts in the palmar side of the distal third of the scaphoid.

The dorsal V consists of the following ligaments:

- Dorsal radiotriquetral ligament (RTD)
- Dorsal intercarpal ligament (ICD)

Both can be visualised on MRI.

The dorsal ligaments are less strong than the palmar ones, however biomechanically they are very important. They converge towards the triquetrum and together with the RLT ligament on the palmar side they prevent the carpus from slipping on the ulnarly angulated distal radial articular surface. The two dorsal ligaments reenforce the dorsal joint capsule.

The RTD ligament runs extrinsically from the dorsal radius obliquely to the dorsal triquetrum. It crosses the proximal scaphoid and the lunate adjacent to the intrinsic SL
and LT ligaments. Usually the ligament's origin is Lister's tubercle of the distal radius, however accessory segments can sometimes be found originaing from the radial styloid or from the more ulnar side of the the dorsal distal radius.

The ICD is an intrinsic ligament. It originates from the dorsal side of the triquetrum and runs in a horizontal fashion across the dorsum of the carpus. One segment inserts in the scaphoid and a second segment in the trapezium and the radial collateral ligament.

We image the carpal ligaments with a 1.5 T MRI scanner (Philips Achieva) with a dedicated wrist coil. We acquire a cor T1W sequence, a 3D Watsc (cartilage) sequence and 3D mFFE sequence. In cases of acute injury we also acquire a coronal STIR sequence for teh demonstration of oedema. The most useful sequence for the assessment of varoius ligaments is the 3D mFFE, which consists of 3 echos which a combined into a single image. This sequence shows ligaments very well. As it is a 3D sequence, reconstruction in the plane of the ligament is possible, which aids diagnosis considerably.

Although the UCL of the metacarpophalangeal joint of the thumb strictly speaking does not belong to the carpal ligaments, it is a frequently injured ligament, usually resulting from violent abduction of an already abducted thumb. Therefore we include it into this review. It runs in a coronal plain (seen in relation to the thumb) from the ulnar side of the thumb metacarpal head to the ulnar side of the base of the proximal phalanx.

Tears of the UCL occur most frequently in the distal aspect near the phalangeal insertion. The torn ligament may be retracted proximally and dorsally, with the distal end displaced to a position superficial to the adductor pollicis aponeurosis, resulting in the so called Stener lesion.

The UCL can be imaged both with MRI with the above mentioned parameters or with US. We prefer US (Philips iU22 with a 17.5 MHz hockey stick probe), as it allows dynamic examination. This is important for the diagnosis of a potential Stener lesion, as movement of the interphalangeal joint of the thumb lead makes the adductor aponeurosis slide over the UCL and a Stener lesion, where part of the aponeurosis is stuck between the ends of the torn ligament, becomes immediately apparent.

The images below show a selection of normal carpal ligaments and pathological conditions.
Fig.: Normal SL (red arrow) and LT (yellow arrow) ligaments.

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: Normal CH ligament.

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: Normal RSL ligament. 

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM

The following three images show the course of the ICD ligament.
**Fig.**: Course of the ICD.

**References:** A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: Course of the ICD.

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: Course of the ICD.

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: The UT ligament.

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: The ligament between the hook of the hamate and the pisiform

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
**Fig.** A torn SL ligament. The defect in the ligament is clearly seen (red arrow). Also note the increased distance between scaphoid and lunate.

**References:** A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
**Fig.**: An avulsion fracture of the ligament between the hamate and the base of the 5th metacarpal at its insertion into the hamate.

*References*: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM

**Fig.**: US of a torn UCL near its insertion into the base of the proximal phalanx.

*References*: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM
Fig.: Intact right UCL of the same patient for comparison.

References: A. Kraus; X-ray department, Ysbyty Gwynedd, Bangor, UNITED KINGDOM

Conclusion

Although imaging of the carpal ligaments can be challenging the use of high resolution ultrasound and 3D MRI sequences helps to achieve a correct diagnosis.

Personal Information

References


