MRI of the TFCC and Interosseous ligaments of the wrist
How to produce a constructive report - What the surgeon needs to know

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Learning Objectives

To understand the anatomy of the scapholunate and lunotriquetral ligaments as well as the triangular fibrocartilage complex.

To recognize and describe pathology of these three structures.

To differentiate incidental perforations from clinically significant abnormalities by specific MRI findings.

To recognize features which alter surgical management
Background

GENERAL.

MRI of the wrist is becoming more valuable to hand surgeons and the reported accuracy of MRI is improving.

Tears and perforations of the major interosseous ligaments and the triangular fibrocartilage complex (TFCC) in the wrist are frequent clinical problems. They are, however, common findings even in asymptomatic individuals.

With the increasing use of MRI prior to arthroscopy, it is becoming necessary for radiologists to assess the clinical significance of these tears and perforations. In addition we must assess the extent of defects/tears and any secondary changes that may occur as a result.

We describe the appearances and demonstrate how to assess whether a tear or perforation is clinically relevant, underlining those findings which help in surgical decision making.

This poster draws on 89 consecutive arthroscopies which had prior MRI examination with our practice, as well as experience and insight derived from 6 years of monthly radiology/surgical MRI case meetings with hand surgeons.

PREVIOUS LITERATURE

Viegas et al\textsuperscript{1} reported on 393 postmortem wrist dissections finding a defect or tear in 36\% of TFCCs, 36\% of lunotriquetral ligaments (LTL) and 28\% of scapholunate ligaments (SLL). Wright\textsuperscript{2} described 62 cadavers with 33\% having TFCC defects, 32\% LTL and 29\% SLL defects.

Further information about the frequency of tears or defects has been estimated from bilateral three compartment arthrograms in patients who have symptoms on one side. Zanetti\textsuperscript{3} described communicating TFCC defects in 64\% of symptomatic wrists with non communicating defects in 50\% of symptomatic and 27\% of asymptomatic wrists - virtually all "radial" sided. In a similar study Yin\textsuperscript{4} et al found communicating defects through the TFCC or interosseous ligaments in 59 of 62 symptomatic and 51 of 62 asymptomatic wrists with half the individuals also showing symmetrical SLL or LTL defects.
The first reports of wrist MRI appeared around 1988-9 and the early papers often quoted extremely good success in assessing the three structures discussed here and yet later reports have often been less encouraging. Anecdotally, many radiologists, even those with musculoskeletal interest, feel uncomfortable with details of intrinsic wrist pathology.

Potter in 1997\(^5\) found MRI to be 97% accurate in assessment of TFCC tears on coronal sequences only, with no clinical guidance, including picking all 29 ulnar sided tears! Many since have reported great difficulty with achieving such results. Oneson in 1997\(^6\) reported accuracy of 83% and 79% for two different readers covering a variety of TFCC tears but there were only 4 ulnar sided tears, 1 reader picking 1 and the other 2 of these.

Shinoya in 1998\(^7\) compared arthrography to MRI, finding MRI less accurate for TFCC abnormalities, with MRI only achieving 73% accuracy - only coronal images studied. Kato in 2000\(^8\) gave an accuracy of 76% with standard and 79% with high resolution MRI but this was only with disc (central and radial) abnormalities.

Blazar\(^9\) also found accuracies of 83% and 61% for two readers, but notably the accuracy for prediction of location was only 69% and 37%; however in their defence any differentiation between central and radial "tears" may be doubtful. Perhaps the most disappointing results, particularly for ulnar sided tears was from Haims et al in 2002\(^10\) who reported a sensitivity of 17% for peripheral tears of the TFCC with similar results for both plain MRI and "indirect arthrography" with intravenous contrast.

For the scapholunate ligament, Schadel-Hopfner\(^11\) reported an accuracy of 75% and Scheck\(^12\) reported a sensitivity of 52% and specificity of 34% for unenhanced MRI.

Haims et al in 2003\(^13\) in a comparison with MR arthrography showed plain MRI to have a sensitivity of 38% and a specificity of 69%.

The results for the LTL have been even poorer with Haims\(^13\) finding a sensitivity of 0%.

Hobby et al in 2000\(^14\) surveyed all articles published to that time on accuracy. Underlining the lack of understanding of these pathologies, their tables quote "complete" tears of the SLL and LTL where one assumes they mean communicating defects (i.e. full thickness), and in the TFCC the distinction is not relevant. One paper they report\(^15\) quotes an accuracy of 84% for the LTL, however they failed to correctly identify any LTL tear!

The majority of these studies have emphasised the coronal plane for assessment of each of these structures which, on viewing their anatomy, is inadequate for full evaluation. Indeed the structurally important segments of the interosseous ligaments should be best
seen on axial images and many TFCC abnormalities are better evaluated on sagittal images.\textsuperscript{16}

OUR EXPERIENCE.

Studies were performed on either a 1.5 or 3T magnet with fat saturated intermediate/proton density sequence in coronal, axial and sagittal planes with small field of view, typically 8cm. and a slice thickness of 2mm. as well as a T1 coronal and a gradient echo axial sequence.

Central and radial TFCC perforations are listed together as they differ in position by only a few millimetres and the differentiation is more by age, history and clinical evaluation.

We identified 95.8\% of all disc defects and tears with no false positive.

Peripheral TFCC tears have a different appearance, are usually non-communicating and may be negative at arthrography. As such, with their different characteristics and anatomy they need to be assessed separately. We have identified all ulnar sided tears (27/27). There are however a number of false positives, 11 cases.

It may be that these are not all real false positives as arthroscopy does not visualise the distal radioulnar joint (DRUJ). It has been shown that some trauma to the TFCC only involves the DRUJ.\textsuperscript{17}

In contrast to previous reports we have broken down and show examples of partial and complete tears of the SLL and LTL as the differentiation is surgically necessary. Our results for the clinically important complete tear are 89\% sensitivity and 98\% specificity. Similarly for the LTL we picked both complete tears with no false positive for complete tears. The full results including partial tear assessment are seen in the table below.

<table>
<thead>
<tr>
<th>TFCC Results</th>
<th>Normal</th>
</tr>
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<tbody>
<tr>
<td><strong>Defect/Tears (sensitivity)</strong></td>
<td><strong>Normal (specificity)</strong></td>
</tr>
<tr>
<td>Central</td>
<td>23/24 (95.8%)</td>
</tr>
<tr>
<td>Peripheral</td>
<td>27/27 (100%)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>SLL Results</th>
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<tbody>
<tr>
<td><strong>Defect/Tears</strong></td>
</tr>
<tr>
<td>Central</td>
</tr>
<tr>
<td>Peripheral</td>
</tr>
<tr>
<td>Partial tear/ perforation (sensitivity)</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>29/34 (85.3%)</td>
</tr>
</tbody>
</table>

**LTL results**

<table>
<thead>
<tr>
<th>Partial (sensitivity)</th>
<th>Complete (sensitivity)</th>
<th>Normal (specificity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13/20 (65%)</td>
<td>2/2 (100%)</td>
<td>11/15 (73.3%)</td>
</tr>
</tbody>
</table>
SCAPHOLUNATE LIGAMENT ANATOMY

The scapholunate ligament (SLL) connects the peripheral portion of the opposing surfaces of the scaphoid and lunate (fig.1). Anatomically it is horseshoe or C-shaped and, if straightened out, is up to 18mm in length and the ligament is between 2 and 3mm in thickness throughout. As such it is a robust and quite large structure. It is composed histologically and functionally of three distinct regions\(^{18}\).

The ligamentous, dorsal region is by far the strongest and as Berger reported in 1998\(^ {19}\) is twice as strong as the volar region which is also ligamentous on histological evaluation. The proximal or membranous portion is composed of fibrocartilage and readily undergoes degenerative perforation in otherwise asymptomatic individuals - it is of limited structural strength. It is also the only area that can be readily seen by arthroscopy in an intact scapholunate ligament without dissociation. It is also the region that is most frequently portrayed on coronal images in text books and journal articles, even though it is the least significant.

Overall the SLL can be thought of as two strong ligamentous bands, volar and dorsal, separated by a fibrocartilaginous midportion.

On MRI both the ligamentous volar and dorsal bands as well as the cartilaginous membranous region demonstrate low signal on all sequences when healthy (fig.2-4) however the volar band may be quite difficult to see well.

SCAPHOLUNATE LIGAMENT PATHOLOGY

Minor degenerative perforations in the fibrocartilage of the membranous / proximal zone are frequent and usually of no clinical importance and are seen as minor discontinuity of the hypointense cartilage or as general increased signal (fig.5).

The literature does not identify which portion of the SLL fails first in an acute traumatic event however; our personal experience suggests that the volar segment fails first (fig.6-9) and depending on the severity of trauma may extend to involve more or all of the SLL. It does appear to be rare to simply have a dorsal tear of the SLL.

Once the strong connection between the scaphoid and lunate is completely disrupted this often puts in progress a series of changes which will eventually result in a SLAC wrist "scapholunate advanced collapse". Surgery for acute tears is designed to eliminate this sequence of events.
In the initial stage of an acute, complete SLL tear, normal quality and signal ligament can be seen, but with avulsion from one side or the other, usually from the scaphoid (fig.10-13). The torn ligament may retain its normal signal for a considerable time and at this stage it is possible that a direct repair of the scapholunate ligament can be accomplished.

With time the signal characteristics alter within the ligament losing the distinct hypo intensity, particularly of the dorsal band, suggesting post traumatic changes (fig.14-15). At this stage it is important to assess other characteristics of the radiocarpal and mid carpal joint. Repair may require a tendon graft.

With the loss of constraint between the scaphoid and lunate, the base of the scaphoid migrates dorsally within the scaphoid fossa of the distal radius (fig.16) and begins to demonstrate volar rotation. At this stage cartilage attrition occurs with a distinct pattern of cartilage loss along the dorsal radial rim (fig.17) as well as through the scaphoid fossa and on the opposing radial border of the scaphoid (fig.18). Inevitably, as in other joints, once full thickness cartilage is lost, subchondral bony changes occur with high signal and often cystic change as well as secondary spurring, particularly around the radial styloid. Surgical options for repair or graft are limited. Radial styloidectomy and general debridement may be performed.

A DISI pattern\(^{20}\) will occur with volar rotation of the scaphoid and dorsiflexion of the lunate increasing the scapholunate angle above 60º. It should be noted that because of the relaxed position required of a wrist in the MRI, the lunate is usually dorsally rotated to some extent and an assessment of the scapholunate angle is necessary to confirm a DISI pattern.

With more advanced change, mid carpal cartilage loss develops, particularly between the lunate and the capitate. Surgical options are limited to stabilisation and fusion.

It is the radiologist's job to assess the extent of changes in order to clearly indicate to the surgeon what the options are prior to arthroscopy/surgery.

**LUNOTRIQUETRAL LIGAMENT ANATOMY.**

The lunotriquetral ligament (LTL) connects the peripheral portions of the opposing surfaces of the lunate and triquetrum. It is far more "V" shaped and somewhat longer than the scapholunate ligament, up to 20mm in laid out length (fig.19). Again there are three histologically distinct regions. The volar band of the LTL is the strongest and thickest being up to 2.5mm in thickness and 8mm in length from proximal to distal. It is composed of true ligamentous fibres.
Ritt et al in 1998 reported that the volar zone is up to 2.5 times as strong as the dorsal and perhaps as much as 12 times stronger than the fibrocartilaginous proximal segment. Despite the differential strength between the volar and dorsal regions, the thinner dorsal region is also highly important functionally, particularly as a restraint to rotation and this may be at least in part be due to the orientation of the fibres. The dorsal band is also a true ligament but probably because of its narrower calibre (1-1.5mm), it can be very difficult to visualise on MRI.

The membranous or proximal zone of the LTL is, like the SLL, fibrocartilage and well demarcated on histological examination from the volar and dorsal regions. It is much thinner than the membranous SLL, often measuring no more than 1-1.5mm. Because it is fibrocartilage it is hypointense on MRI. The volar band is also clearly seen on axial, particularly gradient echo images and is also seen as hypointense striations on coronal proton density fat saturated images (fig.20-22). The alignment of the lunate and triquetrum is also important to assess (fig.23-27).

**LUNOTRIQUETRAL LIGAMENT PATHOLOGY**

Membranous LTL perforations (fig.28) are frequently associated with triangular fibrocartilage complex (TFCC) pathology and particularly with ulnocarpal impaction. On coronal images the line of force through the distal ulna and the articular disc is seen to not only involve the ulnar margin of the proximal lunate but also the membranous portion of the LTL. Attritional, degenerative perforations occur regularly and appear to frequently extend into the dorsal LTL (fig.29-30).

The mode of injury for acute tears is open to conjecture with different authors suggesting fall on an outstretched hand positioned in pronation, extension and radial deviation or a dorsally applied force with the wrist palmer flexed. It is well known that a volar intercalated segment instability (VISI) pattern from lunotriquetral instability also requires associated capsular damage, most likely to the dorsal radiocarpal and intercarpal ligaments. LTL tears are less frequently a clinical problem than SLL or TFCC disruption. Partial tears or perforations which involve the membranous and dorsal portions results in widening of the LTL interspace dorsally (fig.31). Further tearing or tears that involve the entire LTL will result in two patterns of mal-alignment, firstly the classical VISI pattern with lunate tilted forward (it should be noted that any lunate tilted forward on a sagittal MRI must be viewed as highly suspicious for a VISI as most patients naturally fall into a comfortable wrist extension position with the lunate tilted backwards) and secondly, with a complete tear of the LTL, the triquetrum can frequently be seen to be dorsally placed in relation to the lunate on axial gradient echo images and Gilula’s arcs are frequently, albeit subtly, abnormal (figs.32-34).
When there is normal alignment sometimes the only evidence of an extensive tear is loss of the normal hypointense striated appearance of the volar band (fig.35-36).

**TFCC ANATOMY**

Palmer and Werner, in 1981\textsuperscript{24}, described the TFCC as comprising the following regions (fig.37):

1. The triangular fibrocartilage articular disc,
2. The meniscus homologue,
3. The ulnar collateral ligament,
4. The volar and dorsal radioulnar ligaments,
5. The volar ulnocarpal ligaments (ulnolunate and ulnotriquetral),
6. The sub sheath of the extensor carpi ulnaris (ECU) tendon,

It is a complex, three dimensional structure containing numerous histological elements and therefore varying signal on MRI examination.

It is important to note that apart from the articular disc these components are difficult to separate surgically and arthroscopically and cadaver dissection shows an extensive fibrous appearing structure (fig.38-39) joining the radius to the ulnar styloid, lunate, triquetrum and ulna side of the carpus as far as the fifth metacarpal base\textsuperscript{25}.

Nakamura et al in 1996\textsuperscript{26} likened the TFCC to a hammock, a description that is sometimes easy to understand on both sagittal and coronal images.

The articular disc is composed of fibrocartilage and it merges imperceptibly anteriorly and posteriorly with the volar and dorsal radioulnar ligaments which themselves are condensations of the volar and dorsal capsule of the distal radioulnar and radiocarpal joints. The articular disc/TFC is separated from the radius by hyaline cartilage however the radioulnar ligaments attach directly to bone. The ECU tendon appears embedded in the dorsal radioulnar ligament forming a fibrous sub sheath to the ECU tendon. The proximity to the ulnar styloid process and ulnar attachments of the TFCC underscore the potential for ECU damage during ulnar sided TFCC injuries and ulnar styloid fractures.

The volar and dorsal radioulnar ligaments converge towards the ulna styloid to form the triangular ligament. The ulna insertion of the TFCC is variable, both in detail and signal. Most frequently fibres can be seen along the distal radial border of the ulnar styloid and extending into the fovea and base of the styloid\textsuperscript{27}.
More distally the connective tissue that lies volar to the ECU tendon and extends distally from the ulna styloid forms both the meniscus homologue and the ulnar collateral ligament regions of the TFCC which are hard to separate on MRI nor is there particular relevance in seeking to do so. Between the homologue and the triangular ligament is a normal, synovial lined recess, the pre styloid recess which often contains fluid and may be involved in synovitis particularly with ulnar sided tears. It should not be misinterpreted as an ulnar sided tear itself.

On the volar aspect of the TFCC and arising from the volar radioulnar ligament are two ligamentous extensions inserting into the lunate and triquetrum, the ulnolunate and ulnotriquetral ligaments respectively. On fat saturated proton density images The disc, radioulnar ligaments and ulnar insertion should all be hypointense (fig.40-42).

**TFCC PATHOLOGY**

In 1978 Mikic\(^{28}\) demonstrated that all individuals by 40 years of age had degeneration within the articular disc (TFC) with degeneration being most frequent on the proximal/ulnar border presumably related to repeated attrition from rotation. Histological evaluation demonstrates reduced cellularity, mucoid degeneration, fibrillation, erosion, ulceration, thinning and eventually perforation (i.e. a degenerative defect rather than a tear). We know that degenerative perforations are extremely common in older age groups and are probably present in 50% or more of individuals older than 60 years of age\(^{1,2}\). They are commonly associated with chondromalacia of the adjacent ulna or lunate and then subchondral bony changes, the complex known as ulnocarpal impaction (fig.43-46).

Acute traumatic tears are also seen within the triangular fibrocartilage complex particularly with rotational injuries or falling on an outstretched pronated hand.

**Classification:** Palmer in 1989\(^{29}\) gave us the most common classification of TFCC pathology separated into two types: class 1; traumatic and class 2; degenerative as follows:

1A trauma, central perforation.

1B ulnar avulsion.

1C distal avulsion.

1D radial avulsion.

Both ulnar and radial avulsions may be associated with bony trauma.
The degenerative classification is:

2A TFCC degeneration.

2B TFCC degeneration with lunate and or ulnar chondromalacia.

2C TFCC perforation plus ulnocarpal impaction.

2D TFCC perforation plus ulnocarpal impaction plus LTL perforation.

2E as above with frank ulnocarpal osteoarthritis.

It should be noted that some injuries fall outside these guidelines but it is the most commonly used classification by hand surgeons. It should also be observed that the term avulsion for ulnar sided tears is somewhat of a misnomer because a tear of the ulnar side of the TFCC is sometimes more a rent in the fibrous substance with pulling away of fibres rather than a ligament being torn off and floating in the radiocarpal joint in the ulnocarpal joint space. The rents or acute tears within the TFCC structure may communicate between the distal radioulnar joint and the ulnocarpal compartment of the radiocarpal joint but more frequently are non communicating, either being dorsally within the upper surface of the TFCC substance or indeed being a tear in the lining of the distal radioulnar joint distally as has been shown by Ruegger et al.\(^{17}\)

It is notable therefore that simple radiocarpal arthroscopy (wrist arthroscopy usually examines the radiocarpal and mid carpal compartments) will not identify non communicating tears that have occurred in the distal radioulnar joint and this may be a cause of some apparent false positive MRIs. Ruegger in 2007\(^{17}\) pointed out that tears of the ulnar attachment are most commonly (96% of cases) non communicating\(^{16}\). They reported five "false positive" cases with distal radioulnar joint arthrography, and described four of five false positive cases as having non communicating defects. To call these a false positive when arthroscopy has not assessed the undersurface of the TFCC would appear a false premise. Some of the most significant TFCC tears which may lead to distal radioulnar joint instability will involve the deep insertional fibres onto the fovea of the distal ulna and therefore MRI may potentially show important lesions that arthroscopy cannot.

These rents within the TFCC substance are quickly filled with granulation tissue, bright on more T2 weighted sequences or grey "mush" on T1 weighted images (fig.47-48), at which time arthrography will not demonstrate the tear, a significant drawback of arthrography, either CT or MR. Later this granulation tissue will organise into fibrous tissue, and if the defect was large enough, will result in a lax TFCC and failure on arthroscopy of trampolining when probed and be associated with distal radioulnar joint instability. Arthroscopies do report lax TFCCs where no obvious tear is seen and it is assumed that a previous tear has resulted in repair by fibrous tissue and loss of integrity of the TFCC structure, subtle MRI changes including bony avulsions and interruption of normal
structures such as the volar radio-ulnar ligament (fig.49-50). MRI again has the potential to show changes when arthroscopy does not. These observations do impact on the measured accuracy of MRI verses arthroscopy.
Fig. 1: Cadaver specimen. Cut scapholunate ligament in sagittal plane. d - the thick dorsal band, v - volar band and p - proximal or membranous region, l - lunate.

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Fig. 2: Normal scapholunate ligament: Coronal proton density with fat saturation (PDFS).
Normal hypointense appearance of the fibrocartilage of the membranous scapholunate
and lunotriquetral ligaments (arrows)

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Fig. 3: Normal scapholunate ligament: Hypointense dorsal band

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**Fig. 4:** Normal scapholunate ligament: Axial PDFS showing dorsal and volar bands (arrows).

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Fig. 5: Membranous perforation of the scapholunate ligament (arrow). This is of little clinical relevance as an isolated finding. Coronal PDFS.

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**Fig. 6:** Acute volar band tear scapholunate ligament - Axial PDFS showing high signal (arrow) replacing the volar band, injury 6 weeks previously.

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**Fig. 7:** Acute volar band tears scapholunate ligament - Coronal PDFS showing high signal (arrow) replacing the volar band, injury 6 weeks previously.

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Fig. 8: 22-year-old female who had an acute tear of the lunotriquetral ligament (Figure 17). Unremarkable volar band (arrow) on axial PDFS but shown on arthrography (Fig 9) to have a volar tear (arrow) - proven at arthroscopy. The character and abnormalities of the volar band can be hard to judge.

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Fig. 9: T1 FS Coronal image post arthrogram showing volar SL tear (arrow). The character and abnormalities of the volar band can be hard to judge.

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Fig. 10: Subtotal to complete scapholunate ligament tears with good quality ligament with primary repair: a) axial PDFS showing high signal replacing the volar band.

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Fig. 11: PD FS Coronal image shows only a few incomplete dorsal fibres

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Fig. 12: Membranous component SLL (arrow) avulsed from the scaphoid.

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Fig. 13: Acute, complete, SLL tear avulsed from the scaphoid (arrow) who had a primary repair.

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**Fig. 14:** 32 year old male patient; Axial PDFS with complete disruption of SLL. No hypointense dorsal band and volar band replaced by high signal.

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Fig. 15: Coronal PDFS through more dorsal portion of scapholunate interface, no good quality ligament remaining (arrows). Patient had no secondary cartilage loss and was treated by surgery with a graft repair.

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**Fig. 16:** Dorsal shift of scaphoid base, sagittal PDFS with simple dorsal shift.

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Fig. 17: Definite cartilage loss on the dorsal radial rim and opposing scaphoid surface:

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Fig. 18: Demonstrating diffuse cartilage loss throughout the scaphoid fossa of the radius as well as on the opposing radial border of the scaphoid (coronal PDFF).

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Fig. 19: Cadaver specimen. Cut lunotriquetral ligament. v - the thick volar band, d - dorsal band, p - proximal or membranous region, l - lunate.

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**Fig. 20:** Normal lunotriquetral ligament: Coronal PDFS. Normal membranous region (arrow) merging with adjacent bright hyaline cartilage

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Fig. 21: Normal lunotriquetral ligament: axial gradient echo with hyaline cartilage of proximal lunate (shorter arrow) and lower signal fibrocartilage of membranous LTL.

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**Fig. 22:** Normal Lunotriquetral ligament: Coronal PDFS demonstrating hypointense fibres of the volar band.

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Fig. 23: Normal lunotriquetral ligament and alignment on axial gradient echo sequence. Figures 23-27 clearly show the normal relationship of lunate and triquetrum with volar and dorsal bands evident. The dorsal band is frequently difficult to identify.

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Fig. 24: Normal lunotriquetral ligament and alignment on axial gradient echo sequence. Figures 23-27 clearly show the normal relationship of lunate and triquetrum with volar and dorsal bands evident. The dorsal band is frequently difficult to identify.

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Fig. 25: Normal lunotriquetral ligament and alignment on axial gradient echo sequence. Figures 23-27 clearly show the normal relationship of lunate and triquetrum with volar and dorsal bands evident. The dorsal band is frequently difficult to identify.

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Fig. 26: Normal lunotriquetral ligament and alignment on axial gradient echo sequence. Figures 23-27 clearly show the normal relationship of lunate and triquetrum with volar and dorsal bands evident. The dorsal band is frequently difficult to identify.

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Fig. 27: Normal lunotriquetral ligament and alignment on axial gradient echo sequence. Figures 23-27 clearly show the normal relationship of lunate and triquetrum with volar and dorsal bands evident. The dorsal band is frequently difficult to identify.

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Fig. 28: Membranous LTL degeneration on coronal PDFS with loss of normal hypointensity (arrow). These patients usually demonstrate communication on arthrography and defect on arthroscopy as in this case. This image also demonstrates an attritional moderate size defect in the TFC (articular disc) and cartilage thinning and irregularity over the proximal lunate indicating mild ulnocarpal abutment.

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Fig. 29: Coronal PDFS demonstrating a partial tear of the LTL involving dorsal and membranous components (arrow).

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Fig. 30: Axial PD FS demonstrating a partial tear of the LTL involving dorsal and membranous components (arrows).

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Fig. 31: Another partial tear of the LTL at arthroscopy showing widening and angulation dorsally (arrow) of the lunate and triquetral interfaces on axial gradient echo sequence.

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Fig. 32: 21 year old female with an unusual and high grade LTL tear. Coronal PDFS with the triquetrum displaced slightly distally with membranous disruption from the triquetral hyaline cartilage (arrow). The slight malalignment indicates a high grade and probably complete tear, which was proven on an MR arthrogram

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**Fig. 33:** Subsequent MR arthrogram showing a high grade LTL tear on the same patient.
**Fig. 34:** Another complete LTL tear with a step dorsally between the lunate and triquetral cortices indicating complete malalignment (arrows) on an axial gradient echo image.

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**Fig. 35:** Complete tears of the LTL in two patients showing loss of normal hypointense volar band fibres on axial gradient echo image (arrow), demonstrating hypointense spots due to haemosiderin. If you are confident the volar band is missing it would be very unlikely to be anything but a complete tear.

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Fig. 36: Complete tears of the LTL in two patients showing loss of normal hypointense volar band fibres on axial gradient echo image (arrow), showing telltale bone irregularity. If you are confident the volar band is missing it would be very unlikely to be anything but a complete tear.

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**Fig. 37:** TFCC diagram. u - ulna, l - lunate, t - triquetrum, ad - articular disc (TFC), vrul - volar radioulnar ligament, drul - dorsal radioulnar ligament, ull - ulnolunate ligament, utl - ulnotriquetral ligament, psr - prestyloid recess, ecu - extensor carpi ulnaris tendon.

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**Fig. 38:** Looking from the radial side of the disarticulated wrist towards the TFCC and ECU tendon. Lf - lunate fossa (cartilaginous surface of the distal radius)

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Fig. 39: Ulnar side of the TFCC showing the dense mesh of tissue around the fibrocartilage with its contiguous radioulnar ligaments.

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Fig. 40: Normal TFCC: Coronal PDFS, showing the hypointense articular disc of the TFCC

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**Fig. 41**: Sagittal PDFS, showing the articular disc with the adjacent ulnotriquetral ligament (long arrow) as well as the membranous LTL which can sometimes be seen on sagittal images with thin slices (short arrows)

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**Fig. 42:** Axial gradient echo image with the volar radioulnar ligament (arrows). With negative ulnar variance this is often less well visualised.

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Fig. 43: Coronal PDFS, 53 year old female patient with a minor perforation of the articular disc of the TFCC (arrow). Such a lesion is rarely of clinical significance in the absence of signs of ulnocarpal abutment.

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**Fig. 44:** A large defect in the fibrocartilage (long arrows) with subtle cartilage irregularity over the proximal lunate (shorter arrow) - early ulnocarpal abutment:

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**Fig. 45:** Another patient with a large perforation (arrows) subtle cartilage thinning over the proximal lunate and loss of signal in the membranous LTL:

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Fig. 46: Very large perforation in the TFC disc in a patient who has marked positive ulnar variance with cartilage thinning and bone changes as well as a membranous LTL perforation.

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Fig. 47: Recent dorsoulnar TFCC tears in a 14 year old sagittal PDFS demonstrating high signal dorsally (arrow) with rent filled with granulation tissue at arthroscopy.

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**Fig. 48:** A 38 year old female patient, with a coronal T1 image showing replacement of normal hypointense bands by isointense "mush", which was proven to be a dorsoulnar TFCC tear at arthroscopy.

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Fig. 49: Axial gradient echo with intermittent loss of the volar radioulnar ligament and a small cortical avulsion fragment from the ulnar styloid (arrow).

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Fig. 50: An axial PDFS demonstrating a small ganglion in an atypical position, which we have seen a number of times after ulnar sided tears.

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Conclusion

Defects, perforations and tears of the scapholunate and lunotriquetral ligaments as well as the triangular fibrocartilage complex are frequent, even in asymptomatic individuals. The aim of MRI should not be limited to identifying a "hole" but instead should aim to:

1. Describe the extent of any defect.

2. Assess whether traumatic or degenerative.

3. Predict clinical relevance, incidental versus significant.

4. Identify secondary effects which may alter clinical management.
Personal Information
References


