Imaging in the Diagnosis of Ulnar Sided Wrist Pain

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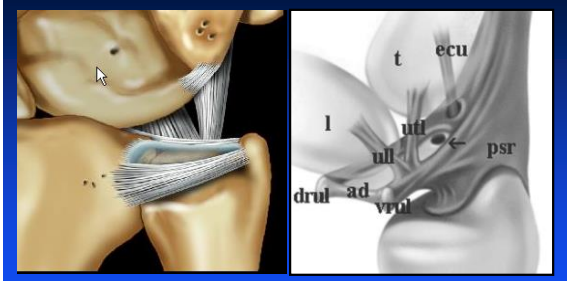
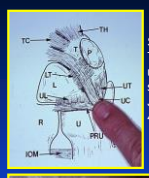
Sources of Ulnar Sided Wrist Pain

- TFCC – foveal attachment – UT Ligament
- Distal Radioulnar Joint
- Extensor Carpi Ulnaris
- LT ligament
- Ulnocarpal Impaction
- Arthritis

Triangular Fibrocartilage Anatomy



"Fovea" sign



S.C. Tay, K. Tomita, R.A. Berger
The "ulnar fovea" sign for defining ulnar wrist pain: an analysis of sensitivity and specificity
J Hand Surg Am 32(4) (2007), pp 438-44

SN 95.2%
SP 86.5%

19 year old collegiate baseball player

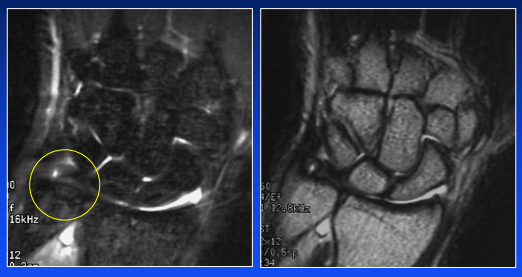
Being recruited by the Yankees

Nephew of a colleague

X-ray slightly supinated

Outside MRI - 1.5T

Outside Diagnosis – Foveal Tear



STIR FSE T2

Diagnosis:

Ulnotriquetral ligament tear -

Partial foveal tear

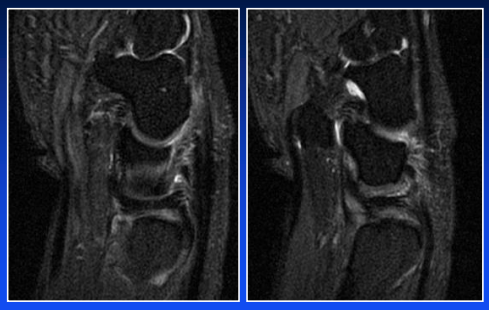
Tx: TFCC and UT repair

Returned to collegiate play after surgery

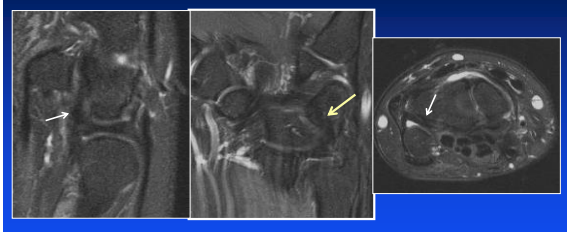
TFCC – Ulnotriquetral Ligament

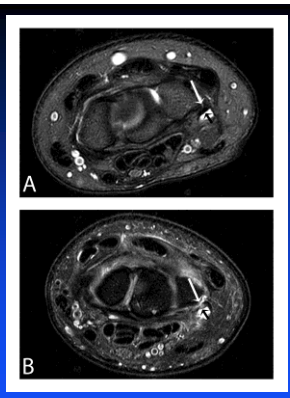
- Important stabilizer of the ulnar wrist
  - But tears may not lead to gross instability
  - Important source of pain
- Complete, partial and "split tears" significant

Can you really see the UTL?



UTL – 3 planes



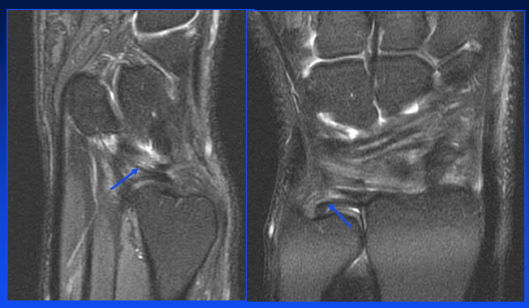


Intact

Split Tear

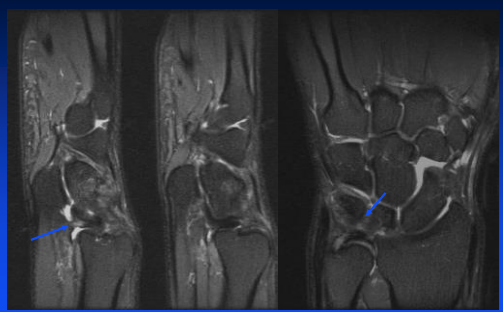
Courtesy Michael Ringler MD

UT Ligament Split Tear

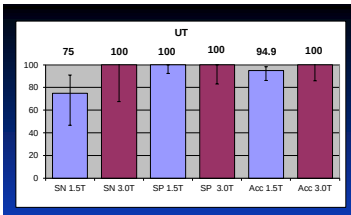


Called Prospectively

UT Split Tear



Missed Prospectively



M.L. Anderson, J.A. Skinner, J.P. Felmlee, R.A. Berger, K.K. Amrami
Diagnostic comparison of 1.5 Tesla and 3.0 Tesla preoperative MRI of the wrist in patients with ulnar-sided wrist pain
J Hand Surg Am, 33 (7) (2008), pp. 1153–1159

100% sensitivity at 3T

M.D.Ringler, B.M.Howe, K.K.Amrami, C.E. Hagen, R.A. Berger
Utility of magnetic resonance imaging for detection of longtudinal split tear of the ulnotriquetral ligament
J Hand Surg Am, 38 (9)(2013), pp.1723-7

30-58% sensitivity 1.5 and 3T

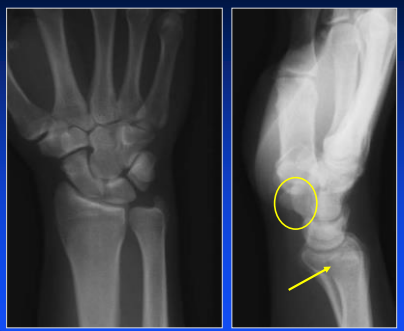
UTL longitudinal split tear detected (committed overall impression)					730
Reader 1	58% (23/40)	60% (12/20)	58% (35/60)	0.59 (0.45 –0.72)	
	(42% to 72%)	(39% to 78%)	(46% to 70%)		
Reader 2	30% (12/40)	60% (12/20)	40% (24/60)	0.55 (0.42 –0.68)	
	(18% to 45%)	(39% to 78%)	(29% to 53%)		

CI, confidence interval; AUC, area under the ROC curve.
* Test for difference in AUC between readers.

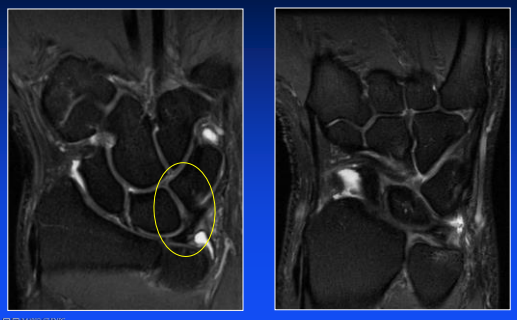
TFCC – Foveal Attachment

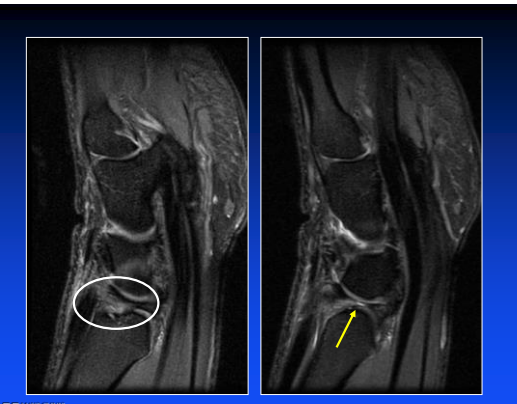
- Foveal attachment
  - Critical attachment for stability
  - High grade partial or complete tears equally significant
  - Healed partial tears with scarring may be challenging
  - Normal synovial reflection can be confusing

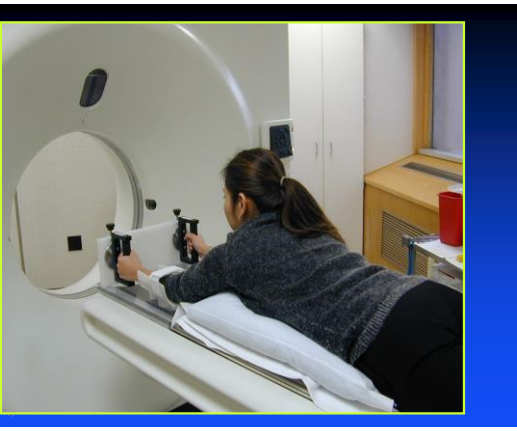
55 yo male with ulnar wrist pain – fell while gardening



Foveal Dissociation – UT Intact

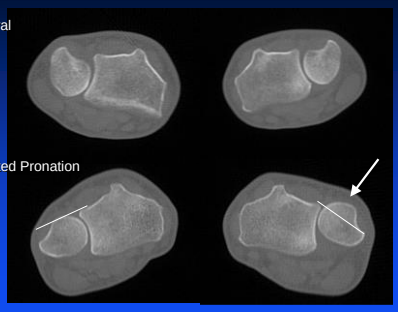






Neutral

Resisted Pronation



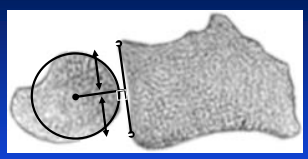
DRUJ Displacement on MRI

- Patients generally imaged in pronation with some resistance (“superman position”)
- Can displacement of DRUJ on axial MRI represent foveal tears as on CT?

Ehman EC et al J Hand Surg am 36(11) 1780-4.

Measurement

Simplified measurement technique



Line spans sigmoid notch

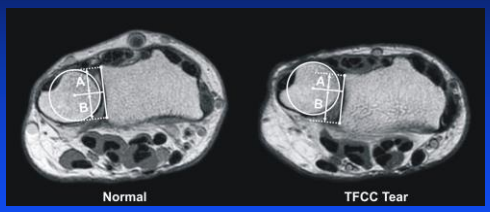
Circle approximates articular curvature of ulna

Ulnar displacement = A/(A+B) x 100% - 50%

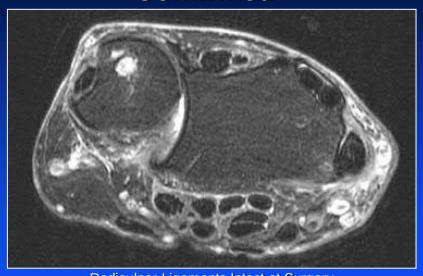
DRUJ Displacement on MRI

- Greater than 15% displacement associated with complete foveal tears 100% of time
- However – over 50% of cases with foveal tears had less than 15% displacement
- Useful as a "check" for second look by radiologist?
  - Usually visually obvious

DRUJ Displacement on MRI



Foveal Tear – Surgically Confirmed

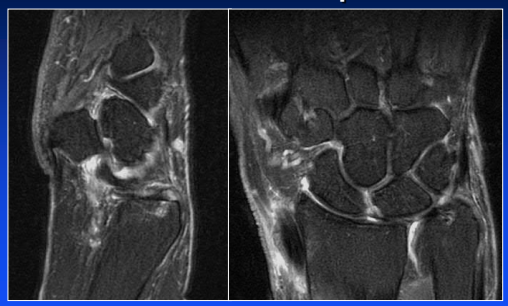


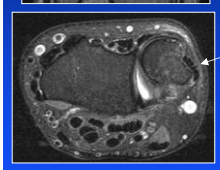
Radioulnar Ligaments Intact at Surgery

Complex tears

- Fovea – body of TFCC – UT ligament
- Tears commonly extend up and down this axis
- Fall on an outstretched hand is a common mechanism

UT, TFCC and Foveal Tears
Foveal Tear is Complete





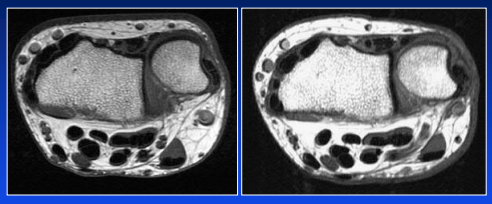
29 yo woman

Complete foveal Tear

ECU Subsheath Tear and Subluxation

Subluxation of the ECU

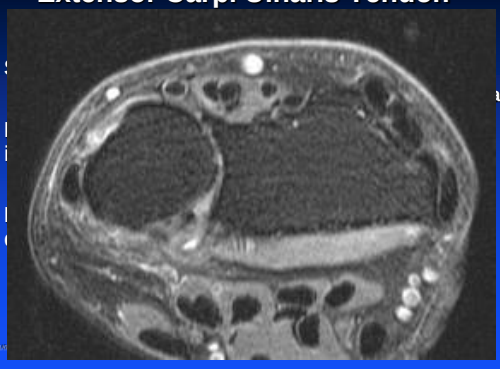
Pre and Post TFCC Reconstruction Repaired Foveal Disruption



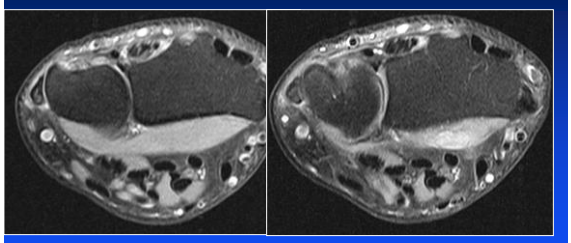
Pre – displaced DRUJ

Post – Normal Alignment

Extensor Carpi Ulnaris Tendon



ECU Subsheath Tear



ECU dislocation with confirmed subsheath tear

Fovea and UT ligament intact

Post-Op Pain

- MRI can assess post op changes and integrity of ligamentous reconstructions
  - Not all pain is a recurrent tear
- Can be imaged through a cast if necessary
- Imaging in the presence of metal also possible

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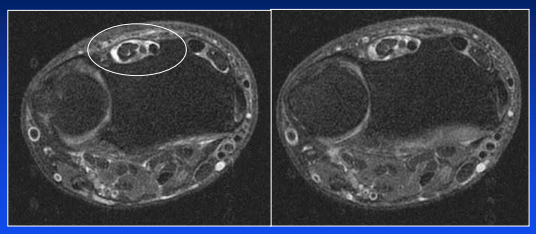
S/P TFCC Repair

Normal Dorsal and Volar Radioulnar Ligaments



Pain related to 4th extensor compartment tenosynovitis

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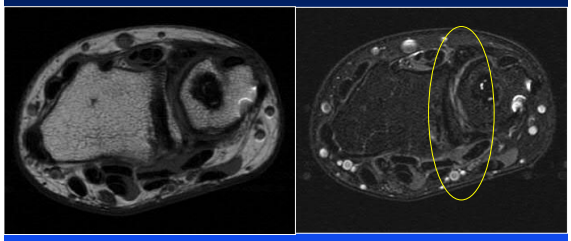
Post-Op Imaging

U-head (3T) DRUJ Reconstruction (3T)

MAYO CLINIC

DRUJ Reconstruction – 3T

Post Op Pain



Intact Reconstruction – degenerative arthritis at the DRUJ

Conclusion

- Ulnar sided wrist pain is a challenging clinical and imaging problem
- Always use your best tools
- Work with your surgeons!

Thanks to:
Richard Berger, MD, PhD
Joel Felmlee, PhD

Wrist MRI and Ulnar Sided Wrist Pain

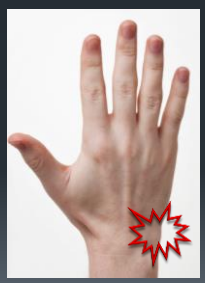
Christopher O. Bayne, MD
UC Davis Medical Center
July 27, 2015

Disclosures

None

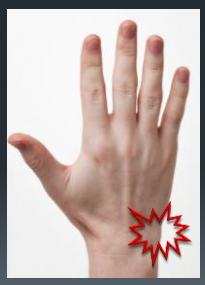
Ulnar Sided Wrist Pain

- Diagnostic challenge
  - Complex anatomy
  - Small size of structures
  - Can cause vague, intermittent sx



Ulnar Sided Wrist Pain

- Differential Diagnosis
  - Osseous
  - Ligamentous
  - Tendinous
  - Vascular
  - Neurologic



Magnetic Resonance Imaging

- **Can be useful**
  - Diagnosis/Treatment
- **Soft tissue lesions**
  - Ligament
  - Cartilage
  - Soft tissue tumor
  - Tendonitis
  - Effusions
- **Bone** (Less osseous detail than CT)
  - Edema/Occult fractures

Magnetic Resonance Imaging

DIAGNOSES:

- TFCC/Ulnar impaction
- Tendonopathy
  - ECU
- Lunotriquetral Ligament Tear

Triangular Fibrocartilage Complex

Anderson et al, JHS 2008

- 1.5 T MRI--85% sens/ 75% spec
- 3.0 T MRI--94% sens/88% spec

Lee et al, MR Imaging 2013

- MR Arthrogram
  - Sensitivity: 93-94%
  - Specificity: 97-100%

Shin AY, et al. JBJS 2004

Anderson ML, et al. J Hand Surg Am. 2008

Triangular Fibrocartilage Complex

CLASSIFICATION

Type 1 (Traumatic)
1A- Central
1B- Ulnar
1C- Distal
1. Transverse *
2. Longitudinal (UT Split)*
1D -Radial

Type 2 (Degenerative)
2A- TFCC wear/thinning
2B- Lunate/Ulna
2C- Perforation
2D- Ligament disruption
2E- Ulnocarpal/DRUJ arthritis

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Tay SC MD, Berger RA, et al. Hand Clin. 2010

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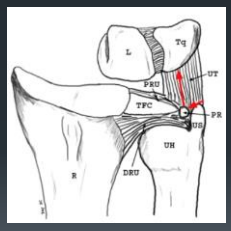


Tay SC MD, Berger RA, et al. Hand Clin. 2010

Ulnar Fovea Sign

95% sensitivity, 86% specificity

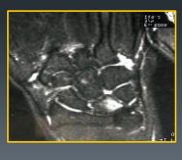
*Tay SC MD, Berger RA, et al. JHS (Am). 2007

Triangular Fibrocartilage Complex

CONSIDERATIONS

- UT split: low sensitivity/specificity
  - MR may be more helpful to exclude concomitant injury

- Ulnar positive variance
  - Check lunate and ulnar head – impaction signs



*Ringler MD, Berger RA, et al. JHS (Am). 2013

Triangular Fibrocartilage Complex

TREATMENT

- Non-operative
  - Acute Type 1
  - First line Type 2
- Steroid injection x 1-3
- Oral and topical NSAIDs
- Splinting/Casting
  - (Muenster, if tolerated)

Triangular Fibrocartilage Complex

OPERATIVE

Arthroscopy vs Open

- **Central:** Debridement
- **Ulnar:** Repair
- **Distal:** repair if mechanical instability/ persistent pain (UT split)
- **Radial:** ? Repair

- **Ulnar Impaction:** ulnar shortening

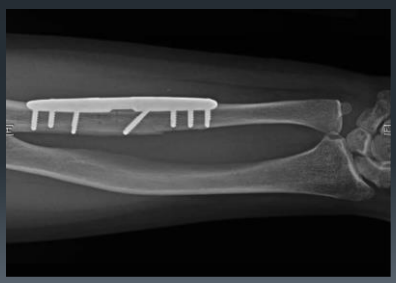
Triangular Fibrocartilage Complex

REPAIR OPTIONS:

- Arthroscopy assisted with extra capsular knot
- All-inside anchor
- Thermal Shrinkage (less favored)
- +/- Ulnar shortening

Ulnar Shortening

Ulnar Shortening



Tendinopathy

Extensor Carpi Ulnaris

Pathology:

- Tenosynovitis
- Rupture
- Subluxation

Tendinopathy

Extensor Carpi Ulnaris

MRI:

- Tenosynovitis - Thickened tendon. Fluid within sheath
- Rupture - Discontinuity of tendon fibers
- Subluxation – Nonspecific, consider dynamic study

Tendinopathy

Extensor Carpi Ulnaris

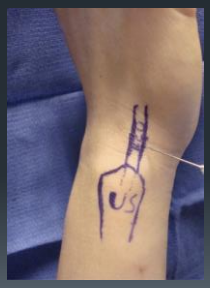
Treatment:

Non-operative

-NSAIDS

-Immobilization: (Muenster Cast/splint 6-8 weeks)

- Tenosynovitis (Consider steroid injection)
- ECU Subluxation
  - Acute injuries
  - 1st line chronic injuries



Tendinopathy

Extensor Carpi Ulnaris

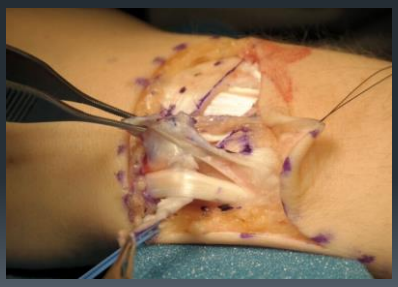
Operative Treatment

- Tenosynovitis (Recalcitrant) –Tx to dorsum of hamate
- Rupture - Repair
- Subluxation – Reconstruction of ECU subsheath/groove deepening

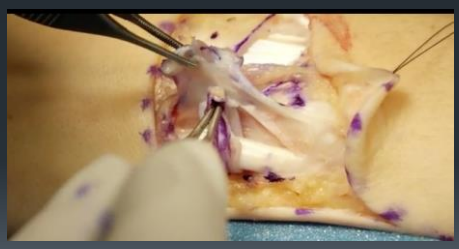
ECU Stabilization

ECU Stabilization

ECU Stabilization

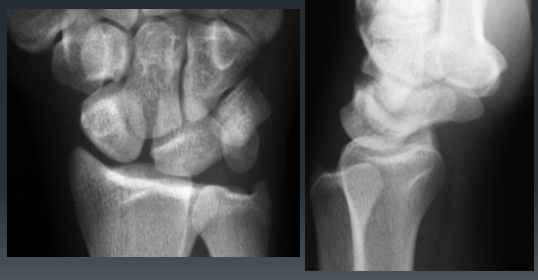


ECU Stabilization



ECU Stabilization

Lunotriquetral Ligament Tear



Images from Alexander Y Shin M.D.

Lunotriquetral Ligament Tear

Summary

- **Ulnar Wrist Pain**
  - Can be challenging
  - History
  - Exam
  - Imaging
    - MRI

Thank you

Imaging of the Scapholunate and Lunotriquetral Ligaments:

Normal anatomy, anatomic variants, and injury assessment

Dr. Jean Jose
Associate Professor Radiology
Associate Section Chief, Musculoskeletal Division
University of Miami
Miller School of Medicine

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE

Disclosure of Commercial Interest

TITLE: Imaging of Scapholunate and Lunotriquetral Ligaments

NAME: Jean Jose

DISCLOSURE OF COMMERICAL INTEREST: My disclosure is in the Final VuMedi Program.

I have no relevant disclosures.

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Introduction

- Carpal instability is often a confusing and challenging topic, in part related to many different patterns of instability and also to the existence of countless intrinsic and extrinsic ligaments.
- Such instability relates to biomechanical alterations with multiple causes that, if not identified and treated in a timely fashion, will lead to gradual articular collapse.
- Understanding requires a basic knowledge of anatomy and pathophysiology, which is critical for the proper prompt diagnosis and treatment of carpal instability.
- Such knowledge can then be applied to the analysis of imaging studies, including MRI, CT and US, allowing a more complete and meaningful diagnosis in cases of wrist instability and a more meaningful conversation between the radiologist and the referring physician.

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE http://radsource.us/carpal-instability/

Dissociative vs. Nondissociative injuries

- **Dissociative**:
  - Results from tear of the intrinsic ligaments.
  - SL or LT dissociation leads to DISI (SLAC) or VISI, respectively.
- **Nondissociative**:
  - Results from a tear of the extrinsic ligaments.

Wrist Instability

- **Pre-dynamic:**
  - Partial ligament tear.
  - Plain radiographs are normal.
  - Soft tissue injury seen with MRI, US, CT, or arthroscopy.
- **Dynamic**:
  - Incompetent or complete ligament tear.
  - Static (non-stress) plain radiographs are normal.
  - Abnormal changes in carpal alignment are seen on stress radiographs/dynamic US/cine MRI.
- **Static (i.e. Scapholunate dissociation)**:
  - Complete SLIL and volar or dorsal extrinsic disruption.
  - Abnormal changes in carpal alignment seen on non-stress radiographs.

Mayo Clinic Classification

- **CID (carpal instability dissociative)-** Intrinsic ligaments
  - Disruption within a row; e.g., SL or LT disruptions/dissociation, scaphoid fracture, and Kienbock's disease (proximal carpal row); or axial carpal dislocations (distal carpal row).
- **CIND (carpal instability nondissociative)-** Extrinsic ligaments
  - Symptomatic carpal dysfunction between the radius and the proximal row, or between the proximal and distal carpal rows, without disruption within or between the bones of the proximal or distal carpal row.
  - CIND is subdivided into radiocarpal and midcarpal patterns.
    - Radiocarpal- insufficiency or disruption of the obliquely orientated extrinsic radiocarpal ligaments –RS, RSC, LRL ligaments- (i.e. RA, Madelung's)
    - Midcarpal- insufficiency or disruption of the triquetro-hamate-capitate (THC), dorsolateral STT, dorsal radiocarpal and RSC ligaments.

Mayo Clinic Classification

- **CIC (carpal instability complex):**
  - Features of CID & CIND
  - Lesser Arc (pure ligament injury) and Greater Arc (transosseous injury)
  - Five groups identified.
    - Dorsal perilunate dislocation (lesser arc injury)
    - Dorsal perilunate fracture-dislocation (greater arc injury)
    - Palmar perilunate dislocation (lesser or greater arc injury)
    - Axial dislocation Isolated carpal bone dislocation
- **CIA (carpal instability adaptive):**
  - Extrinsic to wrist (result from extracarpal pathology); e.g., Malunion of distal radius fracture

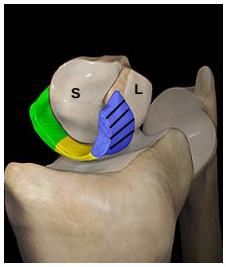
Natural History of SL and LT Instability

- **Static Instability (Scapholunate and Lunotriquetral dissociation)**
  - Interval diastasis > 3 mm
  - Scapholunate dissociation- most common ligamentous cause of carpal instability.
  - Lunotriquetral dissociation- second most common ligamentous cause of carpal instability.
    - Increased frequency of lunotriquetral ligament tears in association with degenerative tears of the triangular fibrocartilage (70% of cases).
- **Dorsal Intercalated Segment Instability (DISI)-**
  - Most common form of carpal instability (dissociative type).
  - Complete SLIL and failure of scaphoid stabilizers (volar extrinsic rupture, with secondary changes in volar RSC, radiolunate, STT (scaphotrapezoid), and dorsal intercarpal ligaments).
  - Scaphoid tilts volarly and the lunate tilts dorsally, both the SL and CL angles are increased (SL > 60˚ , CL > 30˚).

Natural History of SL and LT Instability

- **Volar Intercalated Segment Instability (VISI)**
  - Second most common type of carpal instability (dissociative type).
  - Secondary to disruption of the lunotriquetral ligamentous complex.
  - Results in volar rotation of the lunate and extension of the triquetrum.
  - The SL angle is decreased (SL < 30˚) and the CL angle is increased (> 30˚).
  - The dorsal radiocarpal ligament is also injured in VISI.
- **Scapholunate Advanced Collapse (SLAC)**, degenerative changes typically in the following stages:
  - Stage I: Styloid-scaphoid DJD
  - Stage II: DJD of the proximal scaphoid facet
  - Stage III: Capitolunate DJD
  - Stage IV: Radiolunate/Pancarpal DJD

Anatomy: Scapholunate Ligament



- **C-shaped Ligament: 3 portions**
  - Dorsal
  - Membranous (proximal)
  - Volar
- Dorsal Component
  - Transversely oriented collagen (collagenous structure)
  - Thickest and Strongest (300 N failure force) Component

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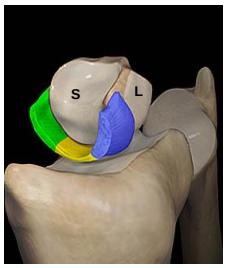
Anatomy: Scapholunate Ligament

- **Dorsal component**
  - Most critical of the SL stabilizers
  - Primary restraint not only to **distraction**, but also to **torsional** and **translational** moments.
  - SLL tear can lead to scapholunate dissociation, which together with **dorsal intercarpal ligament (DICL)** tear results in DISI and SLAC.

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE J Hand Surg 2008;33A:998–1013.

Anatomy: Scapholunate Ligament



- **Volar (palmar):**
  - Collagenous structure
  - Considerably thinner
  - Important contribution to rotational stability
- **Membranous (proximal):**
  - Fibrocartilaginous structure
  - Little to no restraint to abnormal motion

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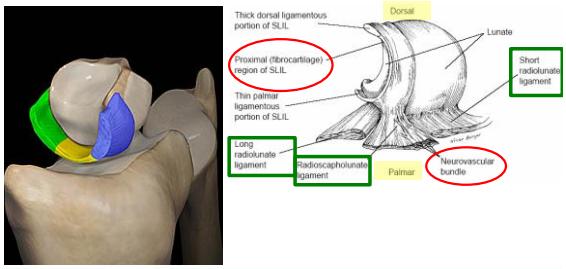
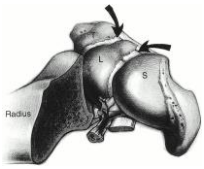
Scapholunate Ligament (SLIL)

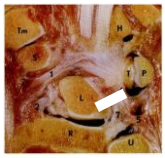


http://radsource.us/sll-tear-and-disi-deformity/

Interosseous Lunotriquetral Ligament

- V-Shaped ligament
- Together with the SLIL, links the bones of the proximal carpal row, allowing synchronous motion.
- Dorsal and volar bands (true ligamentous components, consisting of collagen fascicles) and structurally weaker proximal (central) membranous parts (fibrocartilaginous tissue similar to that of the triangular fibrocartilage).
- The thickest and functionally most important part of the LTL is the volar band, with contributions from fibers of the ulnocapitate ligament. Transmits extension moment of the triquetrum
- LTL tear can lead to lunotriquetral dissociation, which together with a tear of the extrinsic dorsal radiocarpal ligament (DRCL) results in VISI.





RadioGraphics 2011 31:1, 79-80
J Bone Joint Surg Am, 2000 Apr; 82 (4): 578 -578
http://radsource.us/sll-tear-and-disi-deformity/

Interosseous SLL and LTL

- Imaging findings require correlation with the clinical examination results, as ligamentous perforations or tears of the SLL and LTL can also be seen in asymptomatic patients.
- On radiographs, widening of the scapholunate interval of more than 2 mm may indicate SLL disruption.
- However, widening of the scapholunate interval may not occur in all cases of SLL disruption, and widening may occur as a normal variation with lunotriquetral coalition.

RadioGraphics 2011 31:1, 79-80

MRI

- Accurate assessment of SLL and LTL injury with MR imaging is often a diagnostic dilemma.
- Factors that contribute to this difficulty in diagnostic assessment include:
  1. Low image spatial resolution,
  2. Low signal to noise ratio (SNR),
  3. Low contrast resolution,
  4. MRI artifacts (i.e. wrap, pulsation, motion etc),
  5. Suboptimal imaging technique
  6. Normal variant morphology of the ligaments.

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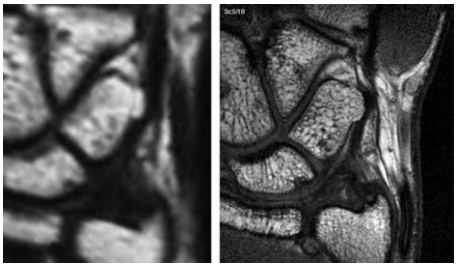
RadioGraphics 2011; 31:63–78

Spatial resolution



Low and high spatial resolution. Note the marginal blurring of anatomic structures and the loss of detail.

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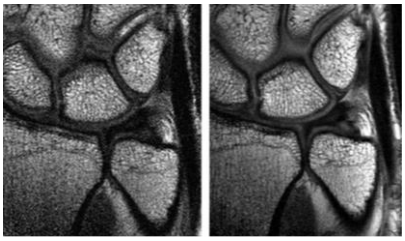
RadioGraphics 2011; 31:63–78

Signal to noise ratio (SNR)



Low and high SNR. Note the increased granularity and the loss of structural information in low SNR image.

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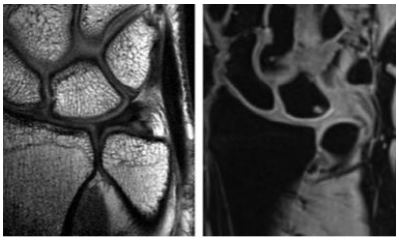
RadioGraphics 2011; 31:63–78

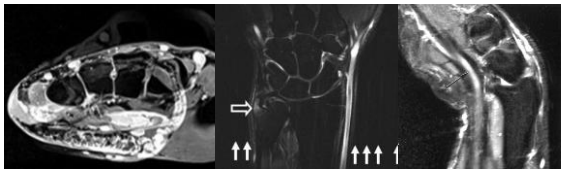
Contrast to noise ratio (CNR)



Coronal gradient-echo (GRE) MR image of the wrist, obtained with low contrast-to-noise ratio, shows preferential loss of small structure detail (eg, the bone trabeculae).

RadioGraphics 2011; 31:63–78

MRI artifacts



- Wrap around artifact
- Nonuniform fat saturation over the ulnar styloid
- Pulsation artifact adjacent to the radial artery
- Magic angle artifact

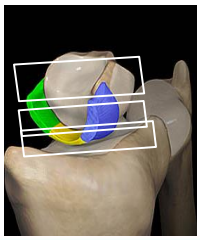
RadioGraphics 2011; 31:63–78
J Magn Reson Imaging. 2011 Apr; 33(4): 908–915
AJNR 2004 25: 431-440

Interosseous scapholunate and lunotriquetral ligament MR assessment

- MRI allows assessment of the three SL and LT ligament components:
  - Volar and dorsal components are best assessed in the axial plane,
  - Membranous segment is best assessed on the coronal plane.

Skeletal Radiol (2014) 43:713–724

Axial MRI: Scapholunate Ligament



- Ligament does not take on strange shapes
- Easy to see volar and dorsal portions as bands
- Suboptimal view of membranous ligament

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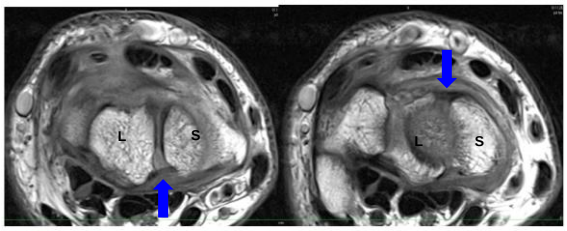
Skeletal Radiol (2014) 43:713–724

Axial MRI: Scapholunate Ligament



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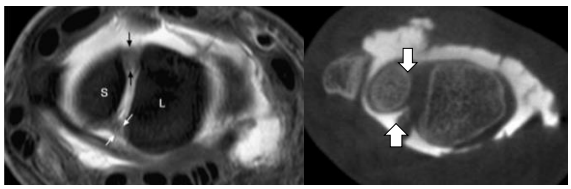
Skeletal Radiol (2014) 43:713–724

Normal dorsal and volar components of the SL ligament "band-like" configuration



MRA CTA

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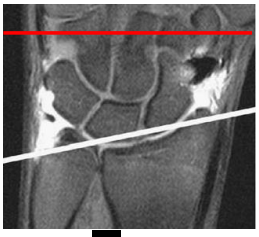
Skeletal Radiol (2014) 43:713–724
Skeletal Radiol (2013) 42:649–657

Oblique axial MR imaging

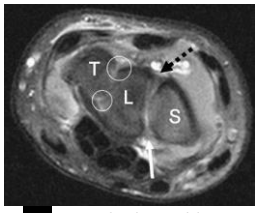


SL

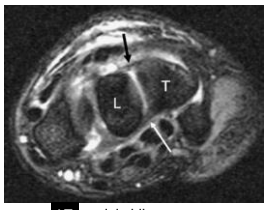
- Improves assessment of the individual ligament components.

Skeletal Radiol (2006) 35: 765–773

Oblique axial MR imaging



SL Conventional true axial



LT axial oblique

- Improves assessment of the individual SL and LT ligament components.

Skeletal Radiol (2006) 35: 765–773

Normal Variant Anatomy

- Lack of familiarity with normal variant anatomic MR imaging appearances of the LTL and SLL may contribute to the suboptimal sensitivity and specificity for lesion detection.
- Therefore, it is important to become familiar with the morphology and signal intensity of the LTL and SLL at high resolution MR imaging to improve the accuracy of diagnosis of ligamentous disease, and to differentiate actual disease from normal or variant appearances.

RadioGraphics 2011; 31:63–78

Normal Variant Anatomy (Coronal Images)

- The SLL varies in shape on coronal images from trapezoidal in its volar aspect to triangular centrally to band-like in its dorsal aspect, all with heterogeneous internal signal intensity.
- On coronal images, the LTL varies in shape from symmetrically triangular to a distorted triangle to a linear conformation, with variable patterns of curvilinear increased internal signal intensity.

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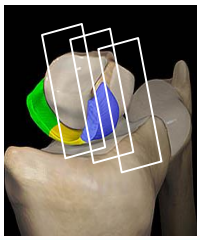
RadioGraphics 2011; 31:63–78

SL : MRI

Coronal MRI



- In the coronal plane:
  - **Volar portion**: trapezoidal and intermediate signal intensity
  - **Membranous portion**: triangular in shape and lower in signal
  - **Dorsal portion**: band-like shape

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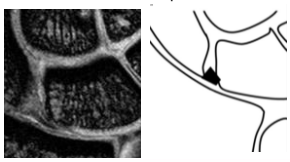
Skeletal Radiol (2014) 43:713–724

MRI Shape of SL Ligament

- Dorsal and volar components of the SLL are band-like.
- The proximal or membranous component of the SLL varies in shape from its volar to its dorsal aspect on coronal images.
  - Volar aspect of the membranous component has a trapezoidal conformation, and attaches scaphoid and lunate cortex.



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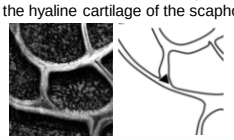
RadioGraphics 2011; 31:63–78

MRI Shape of SL Ligament

- Dorsal and volar components of the SLL are band-like.
- The proximal or membranous component of the SLL varies in shape from its volar to its dorsal aspect on coronal images.
  - Volar aspect of the membranous component has a trapezoidal conformation, and attaches scaphoid and lunate cortex.
  - The central portion of the membranous component is triangular, and attaches to the hyaline cartilage of the scaphoid and lunate in most cases.



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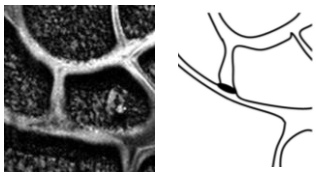
RadioGraphics 2011; 31:63–78

MRI Shape of SL Ligament



- The dorsal aspect of the membranous component is band-like on coronal images, and is variable in attachment, attaching to the cartilage or cortex of the scaphoid and lunate in various combinations.

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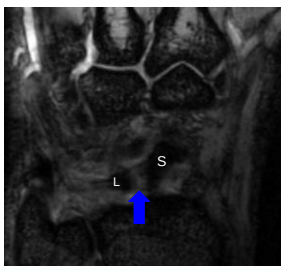
Coronal MRI: Scapholunate Ligament



- **Volar portion:** trapezoidal and intermediate signal intensity
- **Membranous portion:** triangular in shape and lower in signal
- **Dorsal portion:** band-like shape

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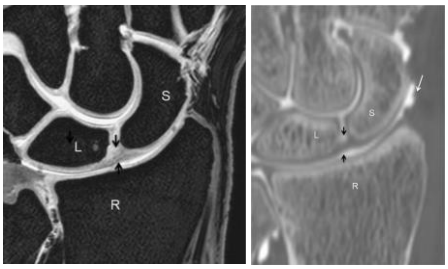
MR and CT Arthrogram

Intact membranous segment of the scapholunate ligament



Skeletal Radiol (2014) 43:713–724

MRI Signal Intensity SLL

- The **volar** portion of the SLL, with its band-like ligamentous structure separated by loose vascular connective tissue, demonstrates striated heterogeneous **increased** signal intensity.
- Similarly, the fibrocartilaginous **membranous** portion has been reported to predominantly demonstrate heterogeneous signal intensity, which ranges from **high-intermediate** signal intensity in its volar aspect to **low signal** intensity in its dorsal aspect.
- The **dorsal** portion of the SLL has **low internal** signal intensity, which is probably due to its constituent elements of homogeneous transversely oriented collagen fascicles.

RadioGraphics 2011; 31:63–78 •

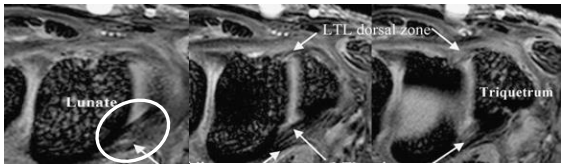
Shape and Signal Intensity LT MRI

- A modified V- shaped configuration, with the dorsal and volar components best seen on axial images, and with the membranous portion best seen in on coronal images.
- The volar and dorsal components appear **band-like** on axial images.
- The membranous portion (proximal zone) of the LTL has a **variety of normal variant shapes and signal intensity** on coronal images.

RadioGraphics 2011; 31:63–78 •

Lunotriquetral ligament (LT)

"Band-Like Configuration"
Dorsal and volar components axial images



- Axial: easiest to see dorsal and volar portions
- Coronal: easiest to see proximal portion

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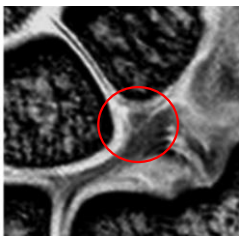
Shape Variations Membranous Portion (proximal zone) of the LTL

- Most commonly triangular or deltoid region (geometry) of low signal intensity (85.6% of cases).
- An alternative conformation of the ligament is a linear or bar-like geometry, which may mimic a tear owing to absence of its distal vertex.
- An indistinct or amorphous shape of the ligament may be seen in asymptomatic older patients; probably the result of **degenerative** change.

RadioGraphics 2011; 31:63–78

Variations in LTL shape

Triangular Morphology



Regular (equilateral triangle) **(41.1%)**

Broad-based isosceles triangle **(20.0%)**

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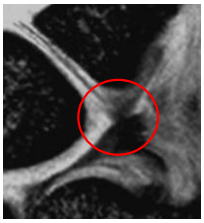
Variations in LTL shape

Triangular Morphology



Asymmetric (scalene) triangle (17.8%)

Narrow-based isosceles triangle (6.7%)

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Variations in LTL shape

Linear or bar-like morphology

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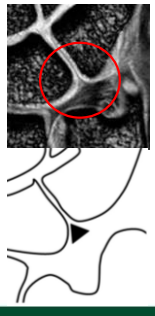
Signal Intensity

- Variation in the internal signal intensity of the membranous portion, categorized as follows:
  - The type 1 variant: uniform low internal signal intensity (33.8% of patients).



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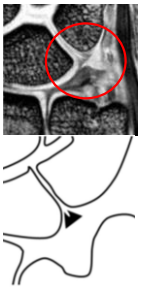
Signal Intensity

- Variation in the internal signal intensity of the membranous portion, categorized as follows:
  - The type 1 variant: uniform low internal signal intensity (33.8% of patients).
  - The type 2 variant: thin line of increased signal intensity inside the triangular body (45.5%).



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Signal Intensity

- Variation in the internal signal intensity of the membranous portion, categorized as follows:
  - The type 1 variant: uniform low internal signal intensity (33.8% of patients).
  - The type 2 variant: thin line of increased signal intensity inside the triangular body (45.5%).
  - The type 3 variant: linear increased signal intensity through the triangle and traversing both the proximal (base) and distal margins of the membranous component (20.8%).

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Shape and signal intensity changes in the LTL with different wrist positions

- The **shape and signal intensity** of the membranous portion of the LTL change when the wrist is positioned in ulnar or radial deviation, as the ligament is very flexible.
- With the wrist in **ulnar deviation**, the triangular shape is distorted and decreased in size in comparison to the appearance with the wrist in the neutral position.
- With the wrist in **radial deviation**, the triangular body becomes wider and higher in internal signal intensity in comparison to the appearance with the wrist in the neutral position.

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Shape and Signal Intensity LTL Changes in Ulnar and Radial Deviation

Neutral

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MRI SL and LT Tear Findings

- **Tears of the LTL and SLL** are diagnosed on the basis of MR imaging findings of:
  1. Irregular morphology,
  2. Abnormal signal intensity,
  3. Fluid (contrast) partially or completely transecting the ligamentous structures.

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SLL disruption

- While complete disruption with static instability may be identified on plain radiographs, less severe injuries may pose a diagnostic dilemma.
- Different imaging modalities such as arthrography, ultrasound, computed tomography (CT) arthrography, and magnetic resonance imaging (MRI) with or without MR arthrography have been proposed for the detection of SLD.
- MRI is the imaging of choice of detection of SL ligament tear.
- Arthroscopy remains the diagnostic gold standard.

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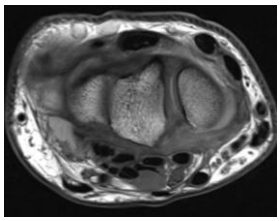
Skeletal Radiol (2015) 44:1103–1110

Interosseous Ligament Tears

- Tears of SLIL and LTL may occur following acute trauma, such as a fall on the outstretched hand, from repetitive stress, inflammatory disease, or degeneration.
- Categorized as:
  - **Complete Tear:** All portions are disrupted.
  - **Full Thickness Tear:** Focally extends through the entire thickness of the ligament.
  - **Partial Thickness Tear:** Involves a portion of the thickness of the ligament.



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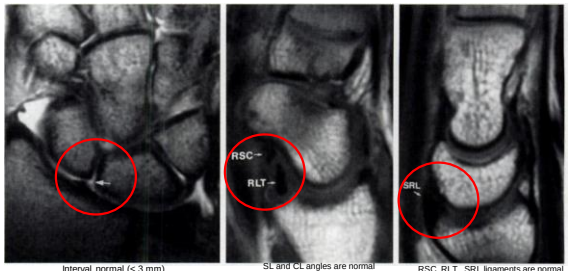
Skeletal Radiol (2014) 43:713–724

Tear of the scapholunate ligament with carpal stability maintained



Interval normal (< 3 mm)

SL and CL angles are normal (SL < 60°, CL < 30°)

RSC, RLT, SRL ligaments are normal

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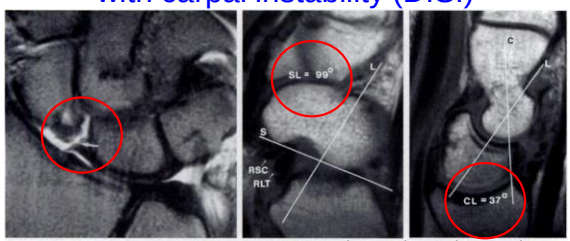
RadioGraphics 1995: 15:575-587

Tear of the scapholunate ligament with carpal instability (DISI)



Interval diastasis > 3 mm

SL and CL angles are increased (SL > 60°, CL > 30°).

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RadioGraphics 1995: 15:575-587

Caution

- Normal lunate appears more dorsally tilted on sagittal MR images than on lateral radiographs, due to wrist positioning in coil. This is particularly exacerbated when the wrist is in ulnar deviation or in pronated position.

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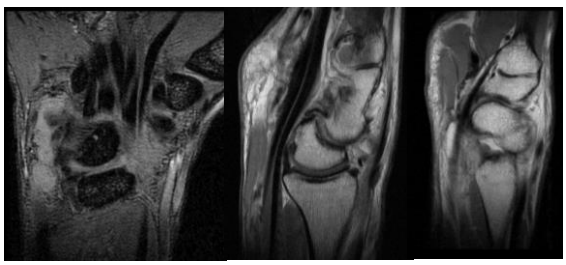
MRI of the Upper Extremity: Shoulder, Elbow, Wrist and Hand. Christine B. Chung, Lynne S. Steinbach - Wolters Kluwer Health 2009

Interval diastasis > 3 mm

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE



Interval diastasis > 3 mm

SL and CL angles are increased (SL > 60˚ , CL > 30˚)

RSC, RLT , SRL ligaments are abnormal

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MRI vs MRA for SL tear

- Non contrast MRI.
  - Sensitivity (41-71 %)
  - Specificity (60-100%)
  - Accuracy (53-100%)
  - Even with the 3.0-T field strength, differentiation between partial and complete dorsal lesions remains difficult.
- MRA allows better evaluation of the SL ligament.
  - Higher sensitivity (50–89 %),
  - Higher specificity (52–100 %)
  - Higher accuracy (60–98 %)
- Axial and coronal views are necessary for thorough evaluation of the C-shaped fibers' continuity.
- In general, the accuracy of diagnosing tears in the volar and dorsal fibers is similar to those of the membranous fibers.

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Skeletal Radiol (2014) 43:725–743
J Wrist Surg. 2013 Feb; 2(1): 69–72

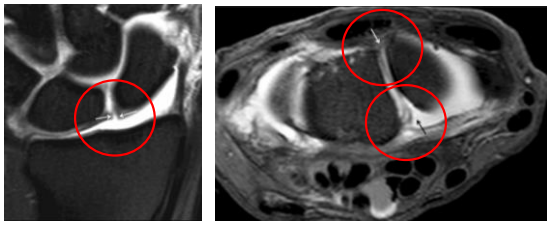
Accuracy of LT tears MRI

- Accuracy of nonarthrographic MR imaging in diagnosing tears of the LTL in clinical studies has also been widely variable and suboptimal,
  - Reported sensitivities of 40%–75%
  - specificities of 64%–100% when arthroscopy was used as the standard of reference.
- Direct MR arthrography appears to be more sensitive in detection of LT lesions
  - sensitivities of 86%–92%) but is not necessarily more specific
  - (specificities of 46%–100%).

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE

RadioGraphics 2011; 31:63–78

SL Ligament tear MRA



Full-thickness tear (*arrows*) of membranous and volar component of scapholunate ligament, with by abnormal communication between the radiocarpal and mid-carpal compartments.
Dorsal SL component is intact.

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Skeletal Radiol (2014) 43:725–743

UM Institutional Review

- We retrospective reviewed MRI's of SL tears and correlated with arthroscopy findings.
- We identified several mistakes in MRI interpretations.

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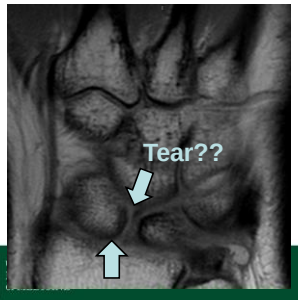
Retrospective Mistake #1

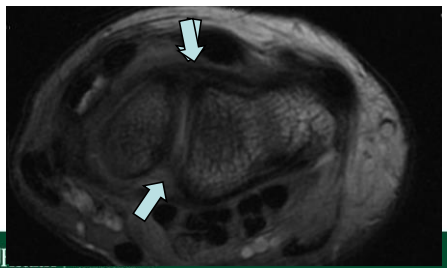
Original Dictation: *Full thickness tear of the dorsal portion based on the coronal sequence*



UHealth

Retrospective Mistake #1

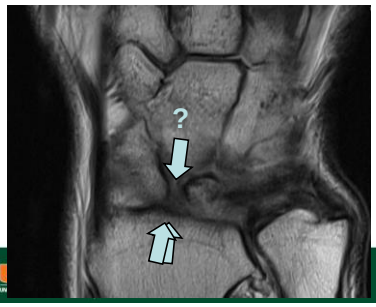
False Positive: *No evidence of SLIL tear!!!*
based on the coronal sequence



UHealth | of MEDICINE

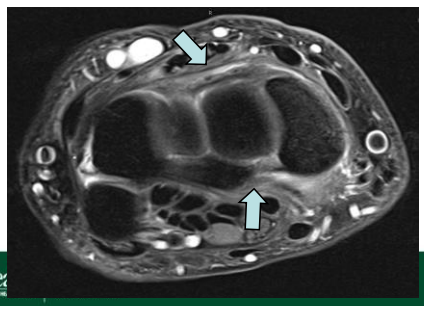
Retrospective Mistakes # 2

Original Dictation: *Full thickness tear of the volar and proximal ligament*



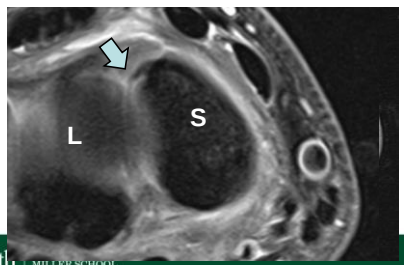
Retrospective Mistake # 2

False Negative: ~~*Full thickness tear of the volar and proximal ligament*~~ ***Complete tear of the SLIL***

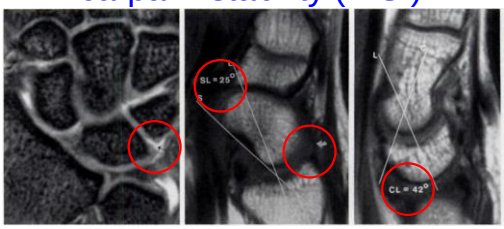


Operative Report…

"…the dorsal portion of the scapholunate ligament was intact to its scaphoid attachment, but not to the lunate side…"



Lunotriquetral ligament tear with carpal instability (VISI)



The SL angle is decreased (SL < 30˚) and the CL angle is increased (> 30˚).
The dorsal radiocarpal ligament is also injured in VISI.

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RadioGraphics 1995: 15:575-587

MRA and CT Arthrogram (CTA)

In certain cases, CTA may increase sensitivity, specificity and accuracy compared with MRA.

MRA of same patient showing torn LT and TFCC

Abnormal CTA- Torn LT and TFCC

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Skeletal Radiol (2013) 42:649–657

MRA and CTA

Coronal

SL membranous component tear, with intact LT and TFCC.
Contrast extends into midcarpal space (asterisk) through SL tear.

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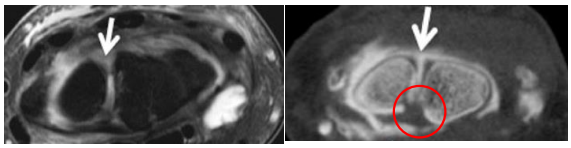
Skeletal Radiol (2013) 42:649–657

MRA and CTA

Coronal



SL dorsal and membranous component tear, with intact volar component.

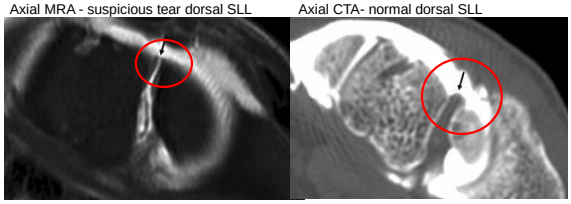
Skeletal Radiol (2013) 42:649–657

SLL tear MRA vs CTA

False Positive

Axial MRA - suspicious tear dorsal SLL

Axial CTA- normal dorsal SLL

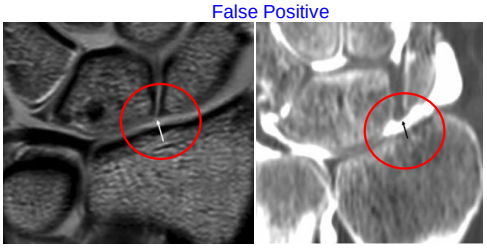


Both CT and MR arthrography have a very high degree of accuracy for diagnosing tears of the SLL and LTL, with both being more accurate than conventional MR imaging.

Skeletal Radiol (2013) 42:1277–1285

SLL tear MRA vs CTA

False Positive

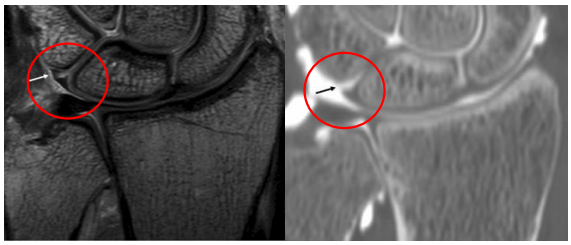


Occasionally, CTA will confirm ligament tears not appreciable with MRA

Skeletal Radiol (2013) 42:1277–1285

LTL tear MRI vs CTA

False negative



Occasionally, CTA will confirm ligament tears not appreciable with MRA

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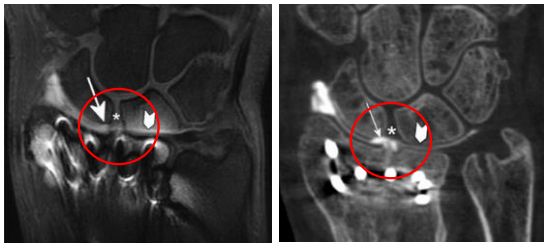
Skeletal Radiol (2013) 42:1277–1285

MRA vs CTA Post-Op



Scaphoid cartilage defect (arrow) is better delineated on the coronal CT-image due to fewer metal artifacts. SL, LT and TFCC are intact.

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Skeletal Radiol (2013) 42:649–657

Conclusion

- Intrinsic and extrinsic ligament defects may be small and insignificant, or lesions that cause significant instability, pain, and chronic disability.
- MRI, US and CT are all useful in the assessment of wrist ligament tears, allowing sensitive detection and detailed assessment, but the examination must be tailored based on clinical considerations.
- Knowledge of the anatomy, dynamic function, and instability patterns is central to evaluating these lesions.
- Accurate assessment of these injuries is important for promptly determining the best conservative or surgical approach to the injured patient.

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http://radsource.us/sll-tear-and-disi-deformity/

Questions and Answers Section

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Cine MRI in diagnosis of scapholunate dissociation

- Cine MRI is an imaging technique that allows acquisition of continuous MR images with high spatial and temporal resolution.
- May be useful in detecting dynamic instability.

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE Skeletal Radiol (2015) 44:1103–1110

Cine MRI

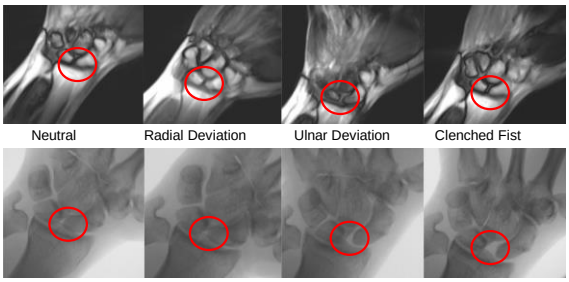
Normal Volunteer
Normal SL interval

Neutral Radial Deviation Ulnar Deviation Clenched Fist

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE Skeletal Radiol (2015) 44:1103–1110

Cine MRI Scapholunate dissociation

Increase SL interval with Ulnar Deviation and Clenched Fist



Neutral | Radial Deviation | Ulnar Deviation | Clenched Fist

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Skeletal Radiol (2015) 44:1103–1110

Sensitivity of US

- Visibility of the SLL and LTL at US varies depending on the equipment and the operator's experience
- Complete visibility of the dorsal band of the SLL in 48-97% and partial visibility in 3-30% of wrists, and complete visibility of the volar band of the SLL in 7-81% and partial visibility in 9-12% of those same wrists.
- Complete visibility of the dorsal band of the LTL in 61% and partial visibility in 39% of normal wrists, and complete visibility of the volar band in 33% and partial visibility in 7% of normal wrists.
- The reported sensitivity of US in depicting lesions of the dorsal band of the SLL varies from 46% to 100%, while specificity varies from 92% to 100%.
- The results are less promising for LTL lesions, with sensitivity varying from 25% to 50% and specificity from 90% to 100%.
- Sonoarthrography in the presence of radiocarpal joint effusion improves the visibility.

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RadioGraphics 2011 31:1, 79-80

SL Ligament Ultrasound

- The SLL and LTL are considered normal if they are seen as echogenic, frequently fibrillar bands in their expected anatomic locations.
- Partially torn ligaments show some irregularity of the fibers.
- The ligaments are considered torn if their fibers are not seen in the expected anatomic locations between the scaphoid and lunate or between the lunate and triquetrum, or if discontinuity of their fibers is seen.
- If a joint effusion is present or sonoarthrography is performed, fluid can be seen in the regions of torn ligaments.

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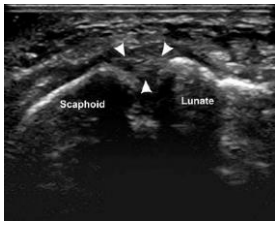
Skeletal Radiol (2014) 43:713–724

SL Ligament Ultrasound

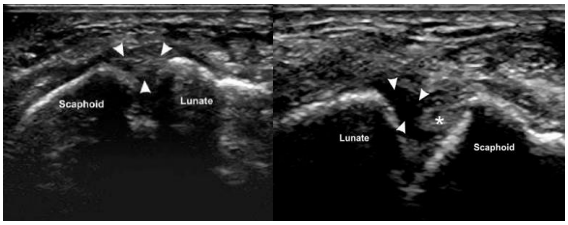


RadioGraphics 2011 31:1, 79-80

US of the dorsal band of the scapholunate ligament with the wrist in pronation and slight flexion.

RadioGraphics 2011 31:1, 79-80

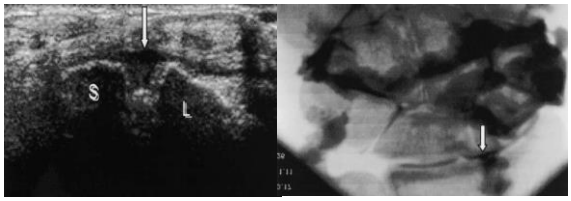
SL Ligament Ultrasound



Normal SL tear

RadioGraphics 2011 31:1, 79-80

Scapholunate ligament tear



SL tear

Arthrogram with contrast injected into the midcarpal joint space confirms SL tear, with contrast appearing in the radiocarpal joint space (arrow)

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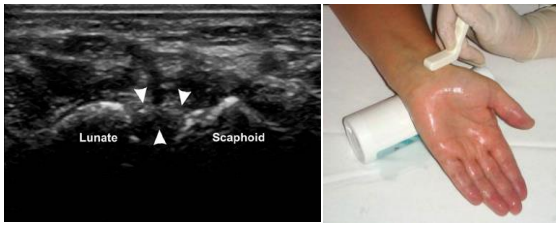
Skeletal Radiol (2004) 33:85–90

Volar band of the scapholunate ligament



Normal

UHealth | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE

RadioGraphics 2011 31:1, 79-80

Volar band of the scapholunate ligament

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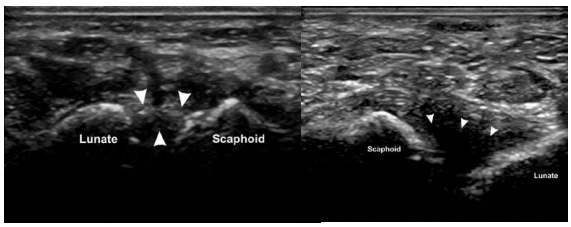
Skeletal Radiol (2005) 34: 513–521

US of the volar band of the scapholunate ligament with the wrist in supination and slight extension.

RadioGraphics 2011 31:1, 79-80

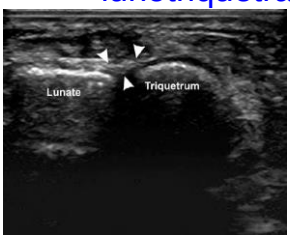
Volar band of the scapholunate ligament



Normal SL tear

RadioGraphics 2011 31:1, 79-80

US Dorsal band of the lunotriquetral ligament

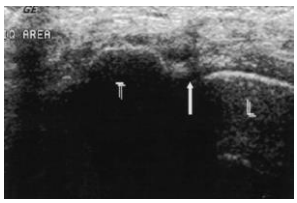


RadioGraphics 2011 31:1, 79-80

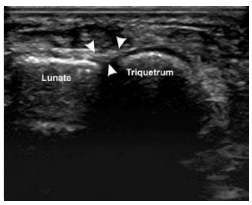
US of the dorsal band of the lunotriquetral ligament with the wrist in pronation and slight flexion.

RadioGraphics 2011 31:1, 79-80

Lunotriquetral ligament tear



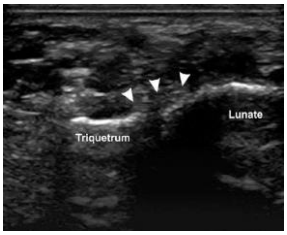
Tear



Normal

Skeletal Radiol (2004) 33:85–90

US Volar band of the lunotriquetral ligament



RadioGraphics 2011 31:1, 79-80

US of the volar band of the lunotriquetral ligament with the wrist in supination and slight extension.

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RadioGraphics 2011 31:1, 79-80

Thank You

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Intercarpal Injuries

VuMedi Webinar
Robert RL Gray
July 27, 2015

Rob Gray, MD
Hand and Microvascular Surgery

NorthShore University HealthSystem

Disclosures

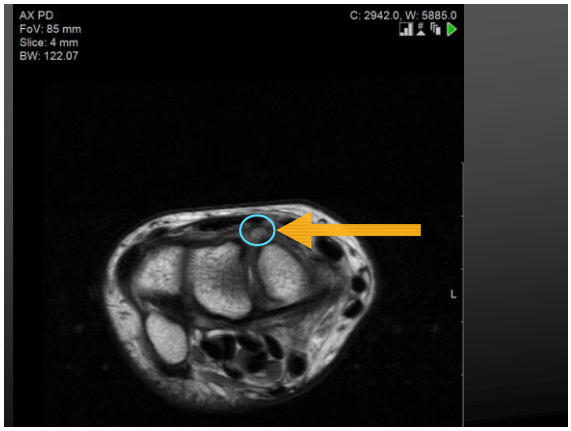
- Reviewer, *Injury*
- Committee Member, ASSH Clinical Outcomes Committee and Flatt Fellows Conference Committee
- Speakers Bureau, Skeletal Dynamics
- Employee, NorthShore University HealthSystem

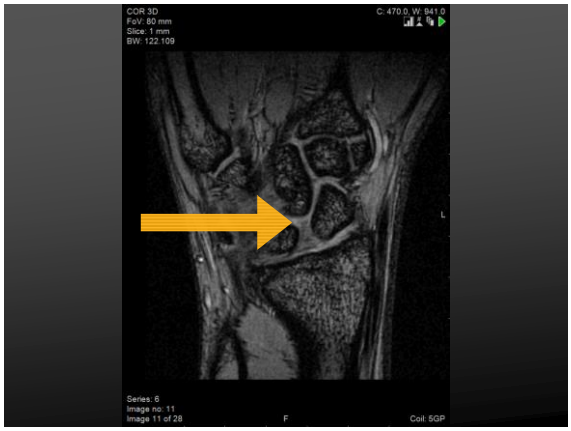
Rob Gray, MD
Hand and Microvascular Surgery

NorthShore University HealthSystem

Mayo Classification of Carpal Instability

- CID (Carpal Instability Dissociative)
- CIND (Carpal Instability Nondissociative)
- CIC (Carpal Instability Combined/Complex)
- CIA (Carpal Instability Adaptive)



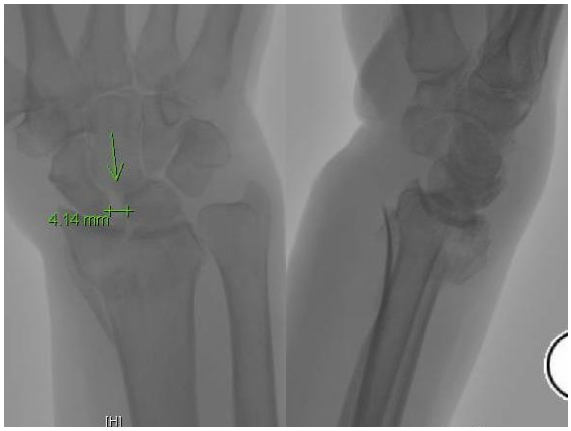


Ganglionectomy

- Open
- Arthroscopic

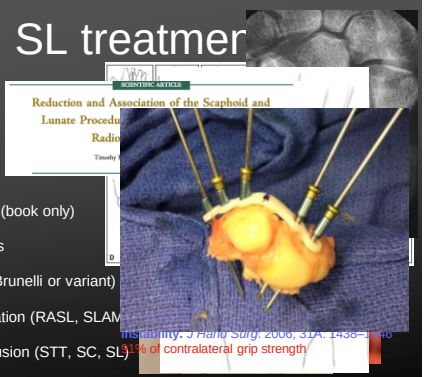
Recurrence rate 5-13%

- US-guided aspiration/injection



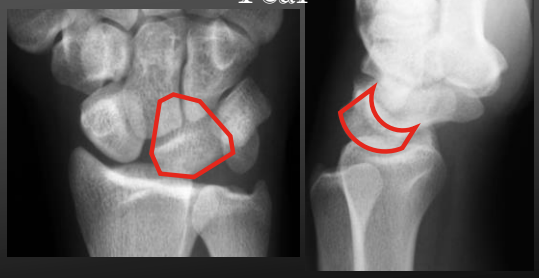
SL treatmer

- Non-op
- Non-op
- Non-op
- Direct repair (book only)
- Capsulodesis
- Tenodesis (Brunelli or variant)
- SL reassociation (RASL, SLAM
- Intercarpal fusion (STT, SC, SL)



instability. *J Hand Surg.* 2006; 31A: 1438–1446
91% of contralateral grip strength

Lunotriquetral Ligament Tear



Images from Alexander Y Shin M.D.

Lunotriquetral Ligament Tear

Lunotriquetral Ligament Tear

MRI:
- Sensitivity 30-50%
- Specificity: 94-97%

MR Arthrography:
- Sensitivity 50-60%
- Specificity 94-97%

Moser T, Dosch JC, et al. Musk Imag 2007

Lunotriquetral Ligament Tear

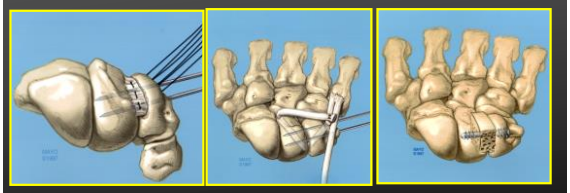
Non-Operative

- Cast immobilization
  - Initial management
  - (Acute/Chronic)
    - Pre-Dynamic
    - Dynamic

Operative

- Static instability
- Dynamic tears not responsive to non-operative treatment

Operative Treatment



Images from Alexander Y Shin M.D.

LT Instability Outcomes

Shin et al 2001

Reconstruction or repair:

- Better strength, motion, pain relief, satisfaction

Arthrodesis more likely to require further surgery at 5 years

(Probability of not requiring further surgery):

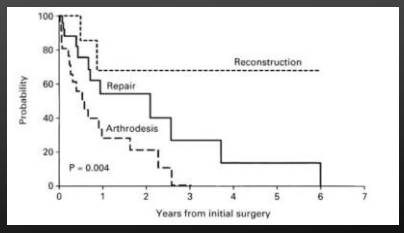
- Reconstruction 68.6%
- Repair 23.3%
- Arthrodesis 21.8%

Shin AY, Berger RA, Bishop AT et a. *JBJS* 2001.

LT Instability Outcomes

Shin et al 2001

COMPLICATIONS:



Shin AY, Berger RA, Bishop AT et a. *JBJS* 2001

Magnetic Resonance Imaging (MRI) of Ligamentous Injury of the Thumb

Harry "Tate" G. Greditzer, IV MD, MSc

Department of Radiology and Imaging
Hospital for Special Surgery
New York, NY

HOSPITAL FOR SPECIAL SURGERY — WHERE THE WORLD COMES TO GET BACK IN THE GAME

Disclosure of Commercial Interest

TITLE: Magnetic Resonance Imaging (MRI) of Ligamentous Injury of the Thumb

NAME: Harry G. Greditzer IV, M.D.

DISCLOSURE OF COMMERICAL INTEREST: My disclosure is in the Final VuMedi Program.

I have no relevant disclosures

Introduction

- The ulnar collateral ligament (UCL) and radial collateral ligament (RCL) are primary stabilizers of the thumb metacarpophalangeal (MP) joint
- Injury to these ligaments may result in joint instability, leading to significant disability and pain
- The diagnosis is best established clinically, though MRI is the imaging modality of choice for grading.

SCIENTIFIC ARTICLE

Gamekeeper's Thumb—A Treatment-Oriented Magnetic Resonance Imaging Classification

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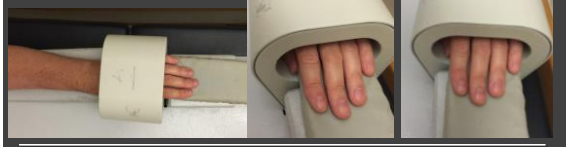
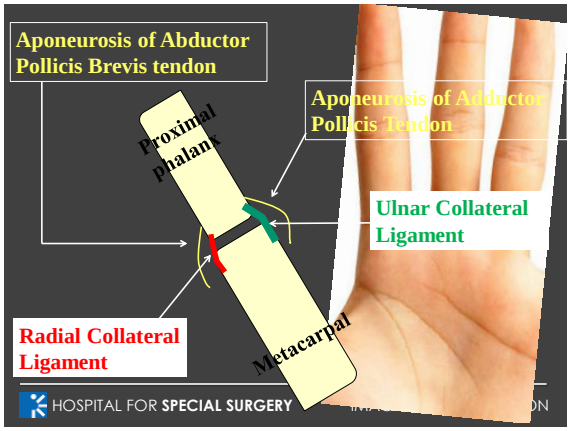
- Magnetic resonance imaging sensitivity and specificity for UCL injury detection approaches 100%
- With the latest generation of dedicated extremity coils, it offers a level of detail that can show the precise location of the torn ligament within the accuracy of a millimeter

MRI Protocol

- Patient supine with arm at their side
- Palm down with thumb in neutral position
- Place in dedicated wrist coil




Aponeurosis of Abductor Pollicis Brevis tendon
Aponeurosis of Adductor Pollicis Tendon
Proximal phalanx
Ulnar Collateral Ligament
Radial Collateral Ligament
Metacarpal
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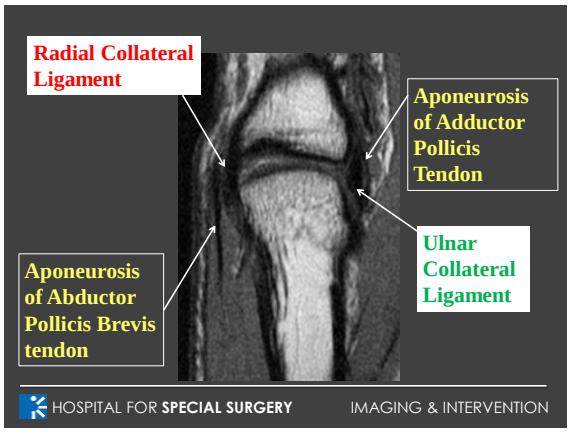
Radial Collateral Ligament
Aponeurosis of Adductor Pollicis Tendon
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Aponeurosis of Abductor Pollicis Brevis tendon
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CASES
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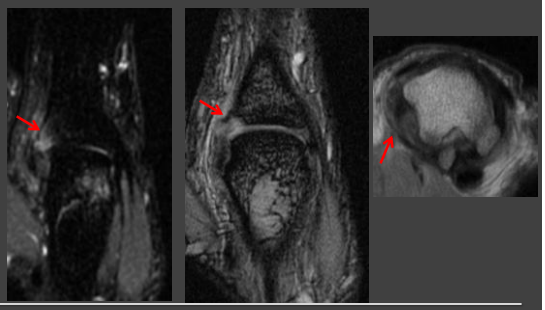
IMAGING & INTERVENTION

Case 1: Fall after skiing 11 days ago



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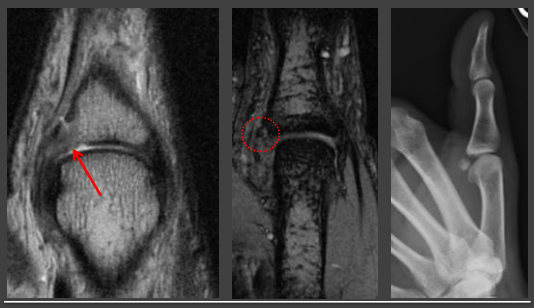

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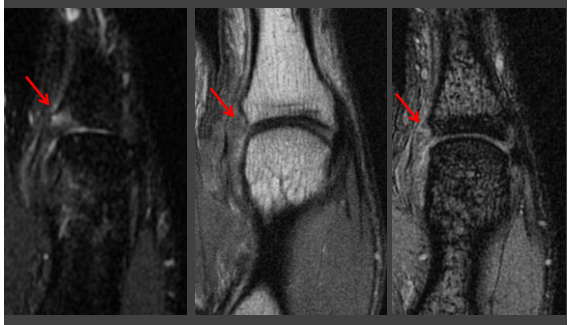
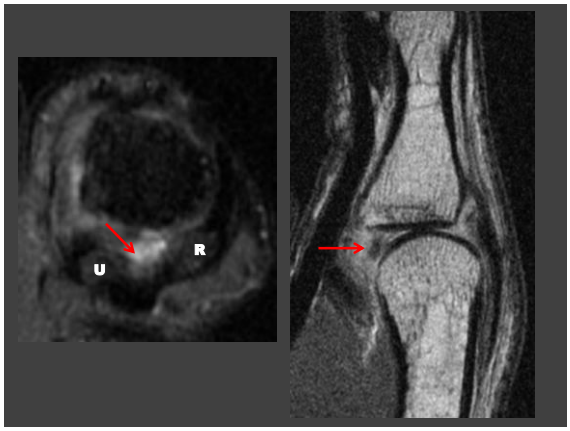
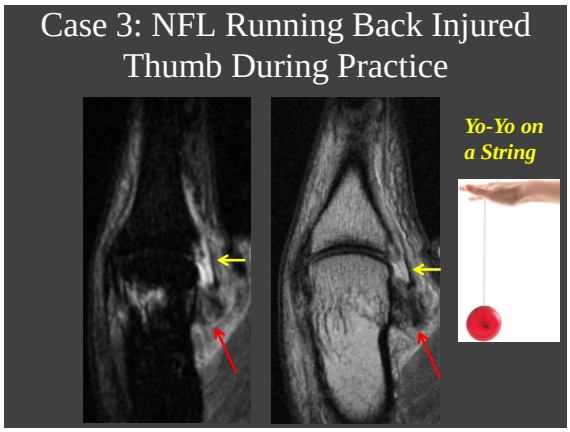
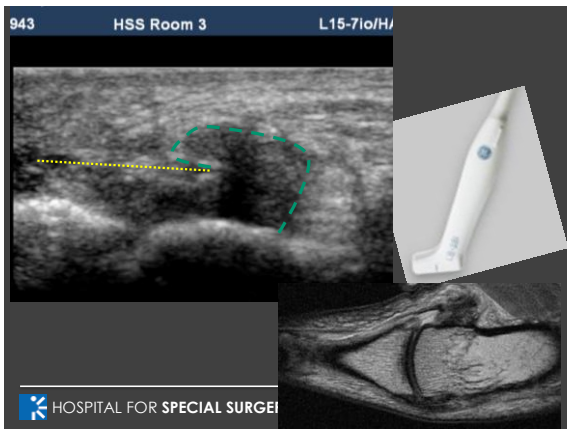
Case 2: Skiing injury 1 month ago



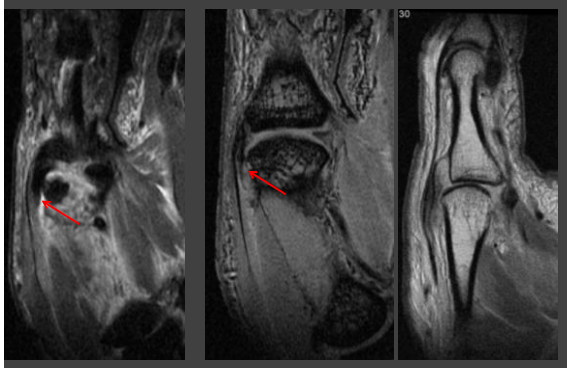


Case 3: NFL Running Back Injured Thumb During Practice





Case 4: 48 y/o male suffers basketball injury



Case 4: 48 y/o male suffers basketball injury

- Radial collateral ligament repair
- Sagittal band repair
- Reduced K-wire

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Summary

- MRI thumb positioning is paramount
- Small FOV and thin slices
- IR first to find the acute injury!
- Coronal plane is useful for ligamentous injury
- Axial and sagittal planes for the plates and sagittal bands

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THANK YOU!

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Surgical Treatment of Thumb MCP Collateral Ligament Injuries

Vumedi Webinar
July 27, 2015

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ONS FOUNDATION
FOR CLINICAL RESEARCH & EDUCATION, INC

Disclosures

- I have no disclosures for potential conflicts of interest specific to this presentation
- Speaker's bureau for Auxilium Pharmaceuticals (Xiaflex)

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Overview

- Ligamentous anatomy
- Exam of thumb stability
- When to order advanced imaging
- How to treat surgically
  - Acute versus chronic injuries
  - Bony avulsions
  - UCL versus RCL
  - Postop protocol

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Ligamentous Anatomy MCP Joint

- Designed to be stable in extension AND flexion
- Dynamic stability
  - Extrinsic stabilizers: EPL, EPB, FPL
  - Intrinsic stabilizers: APB, FPB and adductor pollicis
- Static stability
  - Dorsal capsule and volar plate
  - UCL
    - Proper and accessory
    - Adductor aponeurosis volar and adjacent to UCL
  - RCL
    - Proper UCL originates more dorsally on MC head
    - Abductor aponeurosis dorsal to RCL

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Physical Exam – UCL Rupture

- Resting position of ulnar deviation
- Tenderness to palpation at ligament
- Palplable mass suggests but does not r/o Stenar lesion
- Most importantly test joint stability . . .

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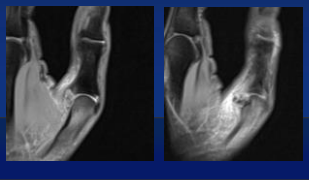
Physical Exam – UCL Rupture

- Evaluation of joint stability to radial/ulnar stress
  - Test MPJ in extension and 30˚ flexion
  - Instability = radial deviation > 35˚ or > 15˚ asymmetry
    - Flexion to test proper collateral ligament
    - Extension to test accessory ligament + volar plate
      - Instability > 35˚ implies tear of proper + accessory collaterals and Stenar's lesion present in 90% (Heyman et al 1993)
      - More reliable bc easy to be deceived by rotation of MC in flexion
  - Local local anesthetic to avoid guarding (Cooper et al 2005)



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Advanced Imaging

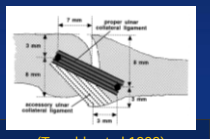
- My indications for MRI:
  - Difficult to get good exam because of guarding
  - Borderline degree of instability (e.g. 25° - 30°)
  - Possible Stenar's lesion (e.g. palpable mass)
  - Assess cartilage in chronic injuries to decide between reconstruction vs fusion
  - NOT needed when clear instability with no form endpoint
- Will change my surgical decision making when:
  - Stenar's lesion
  - Relative indication if highly retracted tear w/o Stenar's lesion
  - Articular injury/arthrosis

Acute UCL Rupture

- Surgical indications:
  - Opening > 35° or 15° from contralateral thumb
  - Stenar's lesion
  - No discrete endpoint to radial stress
  - Relative indication: MRI reveals significant retraction but borderline instability and no Stenar's lesion

Surgical Treatment – Acute UCL Rupture



(Trumble et al 1999)

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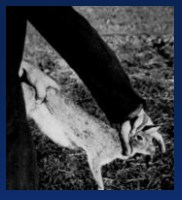
Chronic UCL Rupture

- May be attenuated and difficult to mobilize to anatomic insertion
- Textbook = approx 6 weeks
- Reality = usually some robust local tissue even months later
- If poor local tissue present, may be treated with
  - Dynamic stabilization (EIP/EPB transfer, adductor advancement)
  - Static stabilization with tendon graft (many configurations)
  - MCP fusion if arthritic – important to assess cartilage (XR or MRI)





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Surgical Treatment – Chronic UCL Rupture

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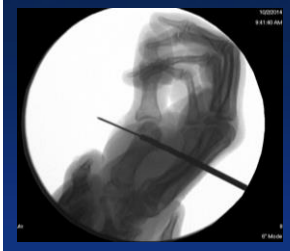
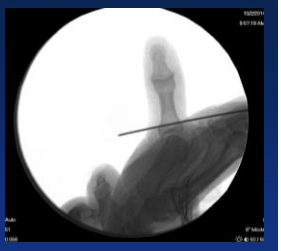
Surgical Treatment – Chronic UCL Rupture





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Surgical Treatment – Chronic UCL Rupture

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Bony Avulsion

- Often compromise stability if involves entire ligament insertion
- Nonunion rates of 25 – 60%
- Significant rotational deformity

- My surgical indications:
  - Fractures a/w significant instability
  - Fractures with significant articular displacement

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Surgical Treatment – Bony Avulsion

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RCL Rupture

- RCL less common, “reverse gamekeeper’s”
  - 10 – 42% of thumb collateral ligament injuries
- Pathoanatomical considerations
  - RCL avulses from MC head 55%, proximal phalanx 29%, midsubstance 16%
  - Greater distal insertional area of RCL
  - No true Stenar’s lesion bc abductor aponeurosis dorsal to RCL and much broader
- Physical Exam
  - Stress testing
  - AP drawer test
    - More likely volar and rotatory subluxation

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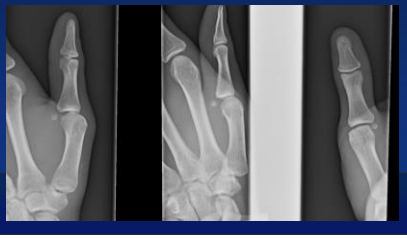
RCL Rupture

- My surgical indications
  - Opening > 35˚ or 15˚ from contralateral thumb
  - No discrete endpoint to valgus stress
  - Significant radiographic volar subluxation or ulnar translation
  - No true Stenar’s lesion equivalent



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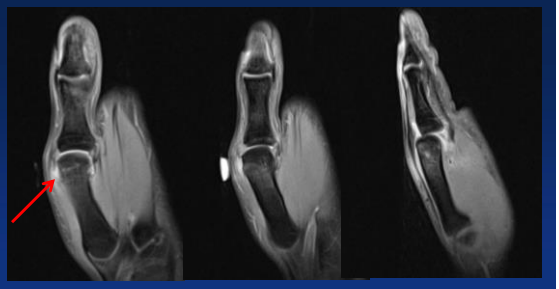
Surgical Treatment – RCL Rupture



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Surgical Treatment – RCL Rupture

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Postop Procotol

- Thumb spica splint/cast with IP free for 3 weeks
- Removable orthoplast splint with therapy supervised by therapist weeks 3 – 6
  - Special attention to the patient with the stiff MP joint
- Splint only for heavy activities weeks 6 - 12
- Return to sport/heavy activity 3 – 4 months

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