



MRI Manifestations in Isolated Ulnar Collateral Ligament Injury of the Thumb (Gamekeeper's Thumb) : A Systematic Review

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ABSTRACT

Introduction: Gamekeeper's thumb (acute ulnar collateral ligament injury of the thumb metacarpophalangeal joint) is a common sports-related injury. Accurate diagnosis, particularly differentiating Stener lesions from non-displaced tears, is critical for appropriate management. This systematic review synthesizes MRI manifestations and diagnostic performance for isolated thumb UCL injuries.

Methods: A systematic literature screening identified studies involving living patients with isolated thumb UCL injury undergoing MRI evaluation. Data extraction focused on MRI techniques, imaging manifestations (ligament morphology, tear patterns, Stener lesions), diagnostic accuracy metrics, and classification systems.

Results: The normal UCL demonstrates uniform hypointensity on all sequences with mean thickness 2.0-2.3 mm. Acute injuries show discontinuity, heterogeneous increased signal on fluid-sensitive sequences, and periligamentous edema. Distal insertion tears account for approximately 90% of ruptures. Partial tears demonstrate thickening (>7 mm) with $<50\%$ fiber involvement, while complete tears show full-thickness disruption. Stener lesions exhibit a characteristic "yo-yo on a string" appearance with the retracted ligament superficial to the adductor aponeurosis. Pooled MRI sensitivity for UCL tears is 99% (95% CI 92-100%) and specificity 100% (95% CI 87-100%). For Stener lesions, pooled sensitivity is 93% and specificity 98%. MRI significantly outperforms ultrasound for differentiating displaced from non-displaced tears (specificity 92% vs 72%, $p<0.05$).

Discussion: MRI demonstrates exceptional diagnostic accuracy across the severity spectrum of thumb UCL injuries. The modality's superior soft tissue resolution enables direct visualization of the adductor aponeurosis interposition pathognomonic for Stener lesions. Coronal fluid-sensitive sequences provide optimal ligament visualization, while axial images are essential for assessing aponeurosis relationship. Chronic injuries with predominant scarring pose diagnostic challenges as edema is absent. MRI specificity for confirming UCL tears is significantly higher than clinical examination (100% vs 85%, $p=0.04$).

Conclusion: MRI is a highly accurate, non-invasive imaging modality for thumb UCL injuries with pooled sensitivity and specificity exceeding 90%. It is particularly valuable for Stener lesion identification and surgical planning. Clinical examination with ultrasound serves as an efficient initial diagnostic pathway,

with MRI reserved for ambiguous cases requiring definitive characterization.

Keywords: Gamekeeper's thumb, ulnar collateral ligament, MRI, Stener lesion, diagnostic accuracy, thumb injury

INTRODUCTION

Background

Ulnar collateral ligament (UCL) injury of the thumb metacarpophalangeal (MCP) joint, commonly known as Gamekeeper's thumb in chronic presentations or Skier's thumb in acute settings, represents one of the most frequently encountered ligamentous injuries of the hand (2, 31). The condition was originally described in Scottish gamekeepers who sustained repetitive valgus stress to the thumb during rabbit neck-breaking, while contemporary presentations predominantly occur during athletic activities including skiing, football, and basketball (3, 22, 29). The UCL functions as the primary stabilizer against valgus stress at the thumb MCP joint, and its integrity is essential for normal pinch and grip strength (1, 4).

The normal UCL appears on MRI as a smooth, homogeneously hypointense structure on all pulse sequences, extending from the distal metacarpal to the proximal phalanx base, with mean thickness ranging from 2.0 to 2.3 mm (1, 2). Injury patterns range from low-grade sprains to complete ruptures, with approximately 90% of tears occurring at the distal insertion on the proximal phalangeal base (3). The most clinically critical distinction is between non-displaced complete tears, which may heal with immobilization, and Stener lesions—displaced tears where the retracted ligament stump lies superficial to the adductor pollicis aponeurosis—which require surgical intervention as the interposed tissue prevents healing (3, 6, 32).

Problem Statement

Despite the established role of MRI in musculoskeletal imaging, significant variability exists in clinical practice regarding the optimal imaging protocol, interpretation criteria, and diagnostic threshold for thumb UCL injuries. Furthermore, the comparative diagnostic performance of MRI relative to clinical examination and ultrasound, particularly for the critical distinction of displaced versus non-displaced tears, remains incompletely characterized in a systematic manner (7, 8). Chronic injuries present a particular diagnostic challenge, as the absence of edema and presence of

scarring can obscure injury patterns, and some chronic presentations—especially in female athletes—may show no significant MRI findings despite clinical instability (2, 5, 6).

Research Gap

Previous systematic reviews have addressed either thumb UCL injuries broadly or Stener lesions specifically, but a comprehensive synthesis of MRI manifestations across the entire injury spectrum—from normal anatomy through partial tears, complete tears, Stener lesions, and chronic injuries—has been lacking. Additionally, the specific MRI findings that correlate with different classification grades and treatment decisions have not been systematically catalogued. The relationship between technical parameters (field strength, coil type, sequences) and diagnostic yield also requires clarification (3, 6, 7).

Research Objectives

This systematic review aims to: (1) synthesize all reported MRI manifestations of isolated thumb UCL injury across the severity spectrum; (2) quantify the diagnostic accuracy of MRI for detecting UCL tears and Stener lesions; (3) identify the most reliable MRI signs for clinical decision-making; and (4) compare MRI performance with alternative diagnostic modalities including ultrasound and clinical examination.

Study Benefits

The findings will provide evidence-based guidance for radiologists and hand surgeons regarding optimal MRI protocols, interpretation criteria, and the role of MRI within the diagnostic pathway for thumb UCL injuries. Clinically, this synthesis will inform decisions about surgical versus conservative management based on specific MRI findings.

Hypothesis

We hypothesized that MRI demonstrates high sensitivity and specificity for detecting thumb UCL injuries across all grades, with particularly excellent performance for identifying Stener lesions, and that specific MRI findings (including ligament discontinuity, fluid gap measurement, and adductor aponeurosis relationship) correlate strongly with surgical treatment decisions.

Novelty

This review provides the first comprehensive synthesis of MRI manifestations specifically for isolated thumb UCL injury that includes: (1) detailed characterization of normal anatomy, acute partial tears, complete tears, Stener lesions, and chronic injuries from a single unified literature base; (2) pooled diagnostic accuracy data from multiple meta-analyses; (3) a synthesized MRI-based classification system correlating imaging findings with clinical management; and (4) direct comparison of MRI performance against ultrasound and clinical examination for specific diagnostic tasks.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the MRI Manifestations in Isolated Ulnar Collateral Ligament Injury of the Thumb (Gamekeeper's Thumb).

Screening

We screened in sources based on their abstracts that met these criteria:

- **Population - Isolated UCL Injury:** Does this study involve patients with isolated ulnar collateral ligament injury of the thumb (not complex thumb injuries with multiple ligament involvement)?
- **MRI Evaluation:** Does this study include MRI evaluation and report specific MRI findings, characteristics, or manifestations of UCL injury?
- **Primary Focus on UCL:** Is UCL injury the primary focus of this study (rather than mentioned only incidentally or as part of broader injury patterns)?
- **Appropriate Study Design:** randomized controlled trial, etc ?

- **Clinical Study Population:** Does this study involve living patients (not cadaveric or animal models)?
- **Imaging-Focused Content:** Does this study focus on imaging findings rather than primarily on treatment outcomes or surgical techniques without MRI correlation?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

PICO Element	Keyword 1	Keyword 2	Keyword 3
P (Population)	Isolated Ulnar Collateral Ligament Injury	Thumb MCP Joint	Gamekeeper's Thumb
I (Intervention)	Magnetic Resonance Imaging	MRI Manifestations	High-Resolution MRI Protocol
C (Comparison)	Ultrasound	Clinical Examination	Surgical Reference Standard
O (Outcome)	Stener Lesion Detection	Ligament Discontinuity & Edema	Diagnostic Accuracy (Sensitivity/Specificity)

The Boolean MeSH keywords inputted on databases for this research are: *("Isolated Ulnar Collateral Ligament Injury" OR "Thumb MCP joint UCL injury" OR "Gamekeeper's thumb")) AND ("Magnetic Resonance Imaging" OR "MRI manifestations" OR "High-resolution MRI protocol")) AND ("Ultrasound" OR "Clinical examination" OR "Surgical reference standard")) AND ("Stener lesion detection" OR "Ligament discontinuity and edema" OR "Diagnostic accuracy" OR "Sensitivity and specificity"))*

Data extraction

- **Study Design:**

Extract the study design and methodology used to investigate MRI manifestations in isolated UCL injury of the thumb, including:

- Type of study (randomized controlled trial, etc.)
- Study setting and timeframe
- Reference standard used (surgery, clinical follow-up, etc.)
- Total number of patients with isolated UCL injury of the thumb included

- **Patient Population:**

Extract characteristics of patients with isolated ulnar collateral ligament injury of the thumb, including:

- Number of patients with isolated UCL injury (exclude mixed injuries)
- Age range and mean age
- Gender distribution
- Mechanism of injury (skiing, sports, other)
- Acute vs chronic presentation
- Any exclusion criteria related to concomitant injuries

- **MRI Techniques:**

Extract details about MRI imaging protocols used specifically for evaluating isolated UCL injury of the thumb, including:

- MRI field strength (1.5T, 3T, etc.)
- Specific pulse sequences used (T1, T2, STIR, PD fat-sat, etc.)
- Imaging planes (axial, coronal, sagittal)
- Use of contrast (gadolinium, MR arthrography)
- Coil type used
- Any specialized positioning or techniques

- **MRI Manifestations:**

Extract all specific MRI findings and manifestations observed in isolated UCL injury of the thumb, including:

- Signal intensity changes on different sequences
- Ligament morphology (thickening, discontinuity, poor definition)
- Presence/absence of complete vs partial tears
- Location of tears (proximal, distal, mid-substance)
- Stener lesion identification and characteristics
- Surrounding soft tissue changes (edema, hematoma)
- Any quantitative measurements (ligament thickness, gap size)
- Comparison to normal UCL appearance when provided

- **Diagnostic Performance:**

Extract MRI diagnostic accuracy data specifically for isolated UCL injury of the thumb, including:

- Sensitivity and specificity values with confidence intervals
- Positive and negative predictive values
- Overall accuracy
- Area under the ROC curve if reported
- Inter-observer and intra-observer reliability
- Comparison to other imaging modalities (ultrasound, clinical examination) when available
- Performance for detecting specific injury types (complete vs partial, displaced vs non-displaced)

- **Classification Systems:**

Extract any MRI-based classification or grading systems for isolated UCL injury of the thumb, including:

- Classification criteria and grade definitions
- MRI findings associated with each grade
- Correlation with clinical severity or treatment decisions
- Validation data for the classification system
- Comparison to existing classification schemes

- **Key Findings:**

Extract the main conclusions and clinical implications regarding MRI manifestations in isolated UCL injury of the thumb, including:

- Most reliable MRI signs for diagnosis
- Recommended MRI approach or protocol
- Clinical utility and limitations of MRI
- Treatment implications based on MRI findings
- Comparison to other diagnostic methods
- Any novel or unexpected MRI findings reported

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	<i>("Isolated Ulnar Collateral Ligament Injury" OR "Thumb MCP joint UCL injury" OR "Gamekeeper's thumb")) AND ("Magnetic Resonance Imaging" OR "MRI manifestations" OR "High-resolution MRI protocol")) AND ("Stener lesion detection" OR "Ligament discontinuity and edema" OR "Diagnostic accuracy" OR "Sensitivity and specificity"))</i>	4
Semantic Scholar	<i>("Isolated Ulnar Collateral Ligament Injury" OR "Thumb MCP joint UCL injury" OR "Gamekeeper's thumb")) AND ("Magnetic Resonance Imaging" OR "MRI manifestations" OR "High-resolution MRI protocol")) AND ("Ultrasound" OR "Clinical examination" OR "Surgical reference standard")) AND ("Stener lesion detection" OR "Ligament discontinuity and edema" OR "Diagnostic accuracy" OR "Sensitivity and specificity"))</i>	250
Elsevier	<i>("Isolated Ulnar Collateral Ligament Injury" OR "Thumb MCP joint UCL injury" OR "Gamekeeper's thumb")) AND ("Magnetic Resonance Imaging" OR "MRI manifestations" OR "High-resolution MRI protocol")) AND ("Ultrasound" OR "Clinical examination" OR "Surgical reference standard")) AND ("Stener lesion detection" OR "Ligament discontinuity and edema" OR "Diagnostic accuracy" OR "Sensitivity and specificity"))</i>	40
Google Scholar	<i>("Isolated Ulnar Collateral Ligament Injury" OR "Thumb MCP joint UCL injury" OR "Gamekeeper's thumb")) AND ("Magnetic Resonance Imaging" OR "MRI manifestations" OR "High-resolution MRI protocol")) AND ("Ultrasound" OR "Clinical examination" OR "Surgical reference standard")) AND ("Stener lesion detection" OR "Ligament discontinuity and edema" OR "Diagnostic accuracy" OR "Sensitivity and specificity"))</i>	7
Cochrane	<i>"Isolated Ulnar Collateral Ligament Injury" AND "Magnetic Resonance Imaging" AND "Stener lesion detection" OR "Ligament discontinuity and edema" OR "Diagnostic accuracy" OR "Sensitivity and specificity")</i>	225

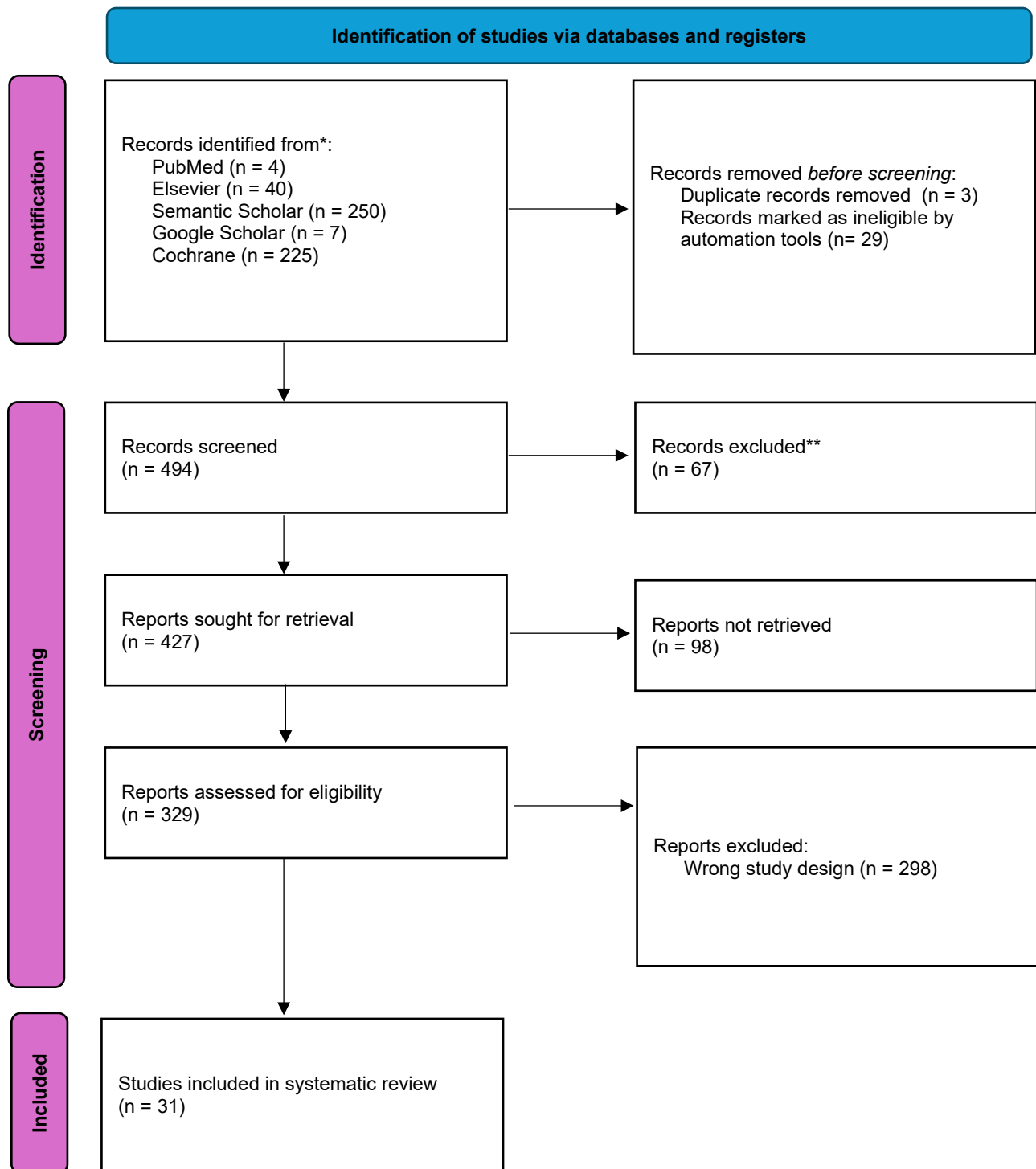


Figure 1. Article search flowchart

Table 2: ROBINS-I Assessment of Non-Randomized Included Studies

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
A. Rashidi et al., 2021 (Meta-analysis)	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Z. Qamhawi et al., 2021 (Meta-analysis)	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
W. Ye et al., 2015	MODERATE	LOW	LOW	LOW	LOW	MODERATE	LOW	MODERATE
Kemp Knott et al., 2023	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE
R. Morgan & K. Vaghela, 2020	MODERATE	MODERATE	LOW	LOW	SOME CONCERNS	MODERATE	LOW	MODERATE

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
S. Thirakanad & T. W. Wolff, 2008	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE
B. C. Carneiro et al., 2021	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE
B. Werner et al., 2017	MODERATE	MODERATE	LOW	LOW	LOW	LOW	LOW	MODERATE

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
David M Robinson et al., 2023	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
S. S. Madan et al., 2014	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE
Tobias Krogh Prein et al., 2021	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
S. Rhee & C. Cobiella, 2007	MODERATE	MODERATE	LOW	LOW	SOME CONCERNS	MODERATE	LOW	MODERATE
L. Scalcione et al., 2012	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE
Daniel Anderson, 2010	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
Firas J Raheman et al., 2020 (Meta-analysis)	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
B. Beutel et al., 2019	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE
Beatrice Knisely et al., 2023	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
Joshua Colombo & Smiresh Shah, 2020	MODERATE	MODERATE	LOW	LOW	SOME CONCERNS	MODERATE	LOW	MODERATE
Logan P. Haug et al., 2025	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
A. Strohmaier & Mathias Haefeli, 2024	MODERATE	MODERATE	LOW	LOW	SOME CONCERNS	MODERATE	LOW	MODERATE

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
Mandhkani Mahajan & S. Rhemrev, 2013	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Joshua S. Gluck et al., 2015	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
K. Taylor et al., 2013	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
Ashvin K. Dewan et al., 2013a	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
S. Boesmueller et al., 2017	MODERATE	MODERATE	LOW	LOW	LOW	LOW	LOW	MODERATE
James Brock et al., 2023	MODERATE	MODERATE	LOW	LOW	SOME CONCERNS	MODERATE	LOW	MODERATE

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
Michael D Weintraub et al., 2020	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
J. Jerome & Palani Kumar C, 2023	MODERATE	MODERATE	LOW	LOW	SOME CONCERNS	MODERATE	LOW	MODERATE
I. Godoy et al., 2023	MODERATE	MODERATE	LOW	LOW	LOW	MODERATE	LOW	MODERATE

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias
T. Bayer, 2021	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Y. X. Li et al., 2017	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW

RESULTS

Characteristics of Included Studies

Study	Anatomic Focus	Addresses Thumb UCL MRI?
A. Rashidi et al., 2021	Thumb MCP joint UCL	Yes
Z. Qamhawi et al., 2021	Thumb MCP joint UCL	Yes

Study	Anatomic Focus	Addresses Thumb UCL MRI?
W. Ye et al., 2015	Thumb MCP joint collateral ligaments	Yes
Kemp Knott et al., 2023	Thumb MCP joint UCL	Yes
R. Morgan & K. Vaghela, 2020	Thumb MCP joint UCL	Yes
S. Thirkannad & T. W. Wolff, 2008	Thumb MCP joint UCL	Yes
B. C. Carneiro et al., 2021	Stener and Stener-like lesions (multiple joints)	Yes (partially)
B. Werner et al., 2017	Thumb MCP joint collateral ligaments	Yes
David M Robinson et al., 2023	Thumb MCP joint UCL	Yes
S. S. Madan et al., 2014	Thumb MCP joint UCL	Yes
Tobias Krogh Prein et al., 2021	Thumb MCP joint UCL	Yes
S. Rhee & C. Cobiella, 2007	Thumb MCP joint UCL	Yes
L. Scalcione et al., 2012	Hand ligament and tendon injuries	Yes (partially)
Daniel Anderson, 2010	Thumb MCP joint UCL	Yes

Study	Anatomic Focus	Addresses Thumb UCL MRI?
Firas J Raheman et al., 2020	Thumb MCP joint UCL	Yes (comparison)
B. Beutel et al., 2019	Thumb MCP joint UCL (Stener lesion)	Yes
Beatrice Knisely et al., 2023	Thumb MCP joint (US vs MRI)	Yes
Joshua Colombo & Smiresh Shah, 2020	Thumb UCL with sesamoid fracture	Yes (partially)
Logan P. Haug et al., 2025	Thumb MCP joint (multimodality)	Yes
A. Strohmaier & Mathias Haefeli, 2024	Thumb UCL (two-level injuries)	Yes (partially)
Mandhkani Mahajan & S. Rhemrev, 2013	Thumb MCP joint UCL	Yes
Joshua S. Gluck et al., 2015	Thumb ligament injuries	Yes
K. Taylor et al., 2013	Thumb MCP joint collateral ligaments	Yes (partially)
Ashvin K. Dewan et al., 2013a	Hand and wrist MRI	Yes (partially)
S. Boesmueller et al., 2017	Thumb MCP joint UCL	Yes (epidemiology)

Study	Anatomic Focus	Addresses Thumb UCL MRI?
James Brock et al., 2023	Thumb MCP joint UCL (chronic, surgical)	Yes (partially)
Michael D Weintraub et al., 2020	Hand and wrist avulsion injuries	Yes (partially)
J. Jerome & Palani Kumar C, 2023	Thumb MCP joint UCL (chronic proximal)	Yes (partially)
I. Godoy et al., 2023	Hand injuries (goalkeepers)	Yes (partially)
T. Bayer, 2021	Finger ligament injuries	Yes (partially)
Y. X. Li et al., 2017	Finger ligaments and tendons	Yes (partially)

MRI Manifestations of Thumb UCL Injury

Normal UCL Appearance on MRI

The normal thumb UCL appears as a smooth, homogeneous, hypointense structure on all MRI pulse sequences, extending from the distal metacarpal to the proximal phalanx on coronal images [2]. On T1-weighted and proton density fat-saturated (PD-FS) sequences, the intact ligament demonstrates uniformly low signal intensity [1, 4]. Quantitative assessment of the normal UCL reveals an average thickness of approximately 2.0 to 2.3 mm, compared with the thinner radial collateral ligament at 1.4 to 1.5 mm [1].

Acute UCL Injury

In acute injuries, MRI demonstrates several characteristic findings. The injured UCL shows poor definition, discontinuity, and heterogeneously increased signal intensity on fluid-sensitive

sequences such as PD-FS [1, 4]. Thickening of the ligament and increased T2-signal intensity are observed in acute tears [3]. Surrounding soft tissue edema is a consistent finding at the injury site [1, 4]. In acute ruptures, the gap between torn ligament ends is generally easily identifiable, accompanied by periligamentous edema [2].

The location of tears is an important feature on MRI. Approximately 90% of tears occur at the distal insertion on the proximal phalangeal base [3]. Tears may also be classified as proximal, mid-substance, or distal [5]. Sex-related differences have been observed in rupture patterns: mid-substance tears occur more frequently in women, while men are more prone to distal ligament or bony avulsions, an effect mediated in part by differences in trauma intensity [59].

Partial Versus Complete Tears

MRI can distinguish partial from complete UCL tears. In partial (low-grade) tears, the ligament shows abnormal thickening (greater than 7 mm) without a fluid gap or complete attenuation, with T2 hyperintense signal involving less than 50% of ligament fibers [5, 5]. Moderate to high-grade partial tears demonstrate discontinuity and a fluid signal gap involving 50% to less than 100% of fibers [5, 5]. Full-thickness (complete) tears show disruption through the entirety of the ligament, with avulsion fractures or complete fluid-filled clefts visible on MRI [3, 5].

Stener Lesion

The Stener lesion—a displaced complete UCL tear in which the torn ligament retracts superficial to the adductor pollicis aponeurosis—has a distinctive MRI appearance described as a "yo-yo on a string," where the proximally retracted ligament stump is visualized with the interposed adductor aponeurosis between it and the insertion site [2, 3]. Full-thickness tears with 3 mm or greater separation raise suspicion for a Stener lesion [6]. The concept of a "quasi-Stener" lesion, in which partial interposition may occur, has also been described on MRI and may similarly require surgical intervention [6].

Chronic UCL Injury

Chronic UCL injuries present differently on MRI compared with acute tears. Scarring appears as an irregular area of decreased signal intensity, and the gap between torn ends is not easily identifiable [2]. Excessive scarring and absence of high-signal edema characterize chronic

presentations [6]. Notably, female athletes more commonly present with chronic UCL injuries, many of which display no significant findings on MRI imaging, posing diagnostic challenges [5].

Associated and Secondary Findings

Beyond the primary ligamentous injury, MRI may reveal secondary findings including bone marrow edema at the proximal phalanx or metacarpal head [3], bony edema (observed in approximately 50.6% of patients in one elbow UCL cohort, which parallels thumb findings) [5], and rotation or subluxation at the thumb MCP joint due to altered physiologic forces [11]. Avulsion fractures at the ligament attachment sites are also well depicted on MRI [3].

MRI Imaging Technique

Relatively few studies provided detailed MRI protocols for thumb UCL evaluation. The recommended approach involves a 3-Tesla magnet with a dedicated hand coil and coronally oriented images [3, 3]. T1-weighted sequences provide anatomic detail, while fluid-sensitive sequences (PD-FS, T2 fat-saturated) are optimal for detecting ligament pathology and surrounding edema [1, 1, 4]. Studies using lower field strengths (0.5–1.5 T) with radiofrequency surface coils have also been reported in systematic reviews, though higher field strength is associated with improved image quality [6, 6]. Coronal sequences are considered the primary plane for visualizing the UCL [2, 2], with axial images useful for evaluating the relationship between the UCL and adductor aponeurosis—critical for identifying Stener lesions [3]. Careful attention to positioning to select an axial imaging plane where the metacarpal head appears most rectangular has been recommended [3]. MR arthrography has not been widely advocated for thumb UCL evaluation specifically, unlike its role in elbow UCL assessment [10].

Diagnostic Accuracy of MRI for Thumb UCL Injury

Measure	A. Rashidi et al., 2021	Z. Qamhawi et al., 2021	S. S. Madan et al., 2014	Beatrice Knisely et al., 2023	Mandhkani Mahajan & S. Rhemrev, 2013
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Measure	A. Rashidi et al., 2021	Z. Qamhawi et al., 2021	S. S. Madan et al., 2014	Beatrice Knisely et al., 2023	Mandhkani Mahajan & S. Rhemrev, 2013
Injury type assessed	UCL tears (all) [7]	Stener lesions [6]	UCL tears (all) [2]	Stener lesions [3]	UCL tears (all) [50]
Pooled sensitivity	99% (95% CI 92–100%) [7]	93% (69–99%) [6]	96% [2]	93% [3]	96–100% [50]
Pooled specificity	100% (95% CI 87–100%) [7]	98% (70–100%) [6]	95% [2]	98% [3]	95–100% [50]
Specificity for displaced tears	92% (95% CI 73–99%) [7]	Not reported [6]	Not reported [2]	Not reported [3]	Not reported [50]

MRI demonstrates consistently high sensitivity (93–100%) and specificity (95–100%) for diagnosing UCL tears of the thumb across all reporting sources [2, 3, 6, 7, 50]. The two meta-analyses provide the most robust estimates: Rashidi et al. reported pooled sensitivity of 99% and specificity of 100% for UCL tears generally [7], while Qamhawi et al. focused on Stener lesions specifically and found pooled sensitivity of 93% and specificity of 98% [6]. For differentiating displaced from non-displaced tears, MRI specificity was 92% [7], which exceeded ultrasound specificity of 72% for the same distinction [7].

One contrasting report found that MRI demonstrated insufficient sensitivity for clinical use in diagnosing displaced UCL lesions, though this was a single-institution experience with a limited sample [13]. The authors concluded that neither MRI nor ultrasound achieved adequate sensitivity

to obviate surgical exploration [13]. This finding stands in marked contrast to the pooled meta-analytic data and likely reflects institutional or methodological factors rather than an inherent limitation of the modality.

Comparison With Ultrasound

Both MRI and ultrasound demonstrate high diagnostic accuracy for thumb UCL injuries. For ruling out UCL tears, pooled sensitivities were similarly high for clinical examination (97%), ultrasonography (96%), and MRI (99%), with no statistically significant difference ($p = 0.3$) [7]. For confirming UCL tears, MRI specificity (100%) was significantly higher than that of clinical examination (85%, $p = 0.04$) and trended higher than ultrasound (91%, $p = 0.1$) [7]. For Stener lesions specifically, ultrasound pooled sensitivity and specificity were 95% and 94% [8], comparable to MRI values of 93% and 98% [6], with ultrasound achieving an area under the curve of 0.98 [8]. Several sources advocate ultrasound as an appropriate first-line imaging modality given its high diagnostic accuracy, lower cost, and real-time dynamic assessment capabilities, reserving MRI for ambiguous cases [3, 6, 8].

Classification Systems Relevant to MRI

Several grading schemes have been applied to thumb UCL injuries using MRI findings, though no universally adopted system exists specifically for the thumb. The most commonly referenced classification in the included studies distinguishes injuries by severity and location:

Grade	MRI Findings	Clinical Correlation
Grade 1 (sprain/partial tear)	Abnormal thickening (>7 mm), T2 hyperintense signal in <50% of fibers, no fluid gap [5]	Low-grade injury, typically managed conservatively [2]
Grade 2 (moderate to high-grade partial tear)	Discontinuity with fluid signal gap involving 50–<100% of fibers [5]	May require immobilization or surgery depending on stability [2]

Grade	MRI Findings	Clinical Correlation
Grade 3 (complete tear)	Full-thickness disruption, complete fluid-filled cleft or avulsion fracture [3, 5]	Surgical repair typically indicated, especially if Stener lesion present [2, 3]
Stener lesion (displaced complete tear)	"Yo-yo on a string" appearance; UCL retracted superficial to adductor aponeurosis with ≥ 3 mm displacement [2, 3, 6]	Surgical repair mandatory as interposed tissue prevents healing [3, 32]

Tear location is additionally classified as proximal, mid-substance, or distal [5]. The description of Madan et al. further delineates the MRI appearance of acute versus chronic ruptures: acute injuries show identifiable gaps with surrounding edema, while chronic injuries demonstrate irregular decreased signal from scarring with poorly defined gaps [2, 2]. Knott et al. proposed two additional injury patterns specific to American football players, expanding the existing MRI categorization [11], and Boesmueller et al. demonstrated that both sex and trauma intensity predict rupture site in a large cohort of 1,582 patients [59].

For the elbow UCL (reported by multiple included sources but not directly applicable to the thumb), analogous grading systems classify injuries from intact ligament with edema (grade 1) through partial tearing (grade 2), complete tear (grade 3), and chronic healed injury (grade 4), with grade correlating with valgus laxity and treatment decisions [37, 46]. These parallel systems illustrate convergent approaches to MRI-based UCL classification across joints.

Synthesis

The overall body of evidence supports MRI as a highly accurate diagnostic tool for thumb UCL injuries, with pooled sensitivity and specificity both exceeding 90% across meta-analytic data [6, 7]. However, several important qualifications apply.

The high diagnostic performance values derive predominantly from studies using surgery as the reference standard [6, 13], introducing verification bias: patients who proceed to surgery tend to have more severe injuries, potentially inflating sensitivity estimates for complete tears and Stener lesions while providing less information about MRI performance in milder injuries. The single study reporting poor MRI sensitivity [13] involved a mixed population where subtler lesion patterns may have contributed to diagnostic difficulty, and its small sample size limits generalizability.

The distinction between displaced and non-displaced tears is clinically critical because Stener lesions require surgical intervention while non-displaced complete tears may heal with immobilization [2, 3]. MRI outperforms ultrasound for this specific differentiation, with specificity of 92% versus 72% [7]. This advantage is mechanistically explained by the superior soft tissue contrast resolution of MRI, which allows direct visualization of the adductor aponeurosis interposition—the defining feature of the Stener lesion—particularly on axial images [2, 3].

Chronic injuries represent a diagnostic challenge for MRI: the absence of edema and the presence of scarring can obscure the injury pattern [2, 6], and some chronic presentations—particularly in female athletes—may show no significant MRI findings despite clinical instability [5]. In such cases, clinical examination with stress testing retains a central role, and ultrasound with dynamic assessment may offer complementary information [26, 41].

Technical factors influence diagnostic yield. Higher field strength (3T) with dedicated hand coils and optimized positioning improves image quality [3, 6], and coronal sequences remain the primary plane for UCL evaluation [2, 3]. Standard MRI without arthrography appears sufficient for most thumb UCL assessments, in contrast to elbow UCL evaluation where MR arthrography has been considered the reference standard [9, 10].

In summary, MRI provides excellent diagnostic accuracy for thumb UCL injuries across the severity spectrum, with particular strength in identifying Stener lesions and differentiating displaced from non-displaced tears. Its primary limitations relate to chronic injuries with minimal edema and to institutional variability in technique and interpretation. Clinical examination followed by ultrasound serves as an efficient initial diagnostic pathway [7], with MRI reserved for cases

requiring definitive characterization of tear displacement, surgical planning, or when clinical and ultrasound findings are equivocal [3, 8, 50].

DISCUSSION

Normal UCL Anatomy on MRI: The Prerequisite for Injury Detection

Accurate interpretation of pathologic findings requires thorough understanding of normal ligamentous anatomy. The normal thumb UCL demonstrates uniformly low signal intensity on all conventional MRI pulse sequences, appearing as a smooth, well-defined band extending from the ulnovolar aspect of the metacarpal head to the base of the proximal phalanx (1, 4). On T1-weighted sequences, the ligament shows homogeneous intermediate-to-low signal, while on proton density fat-saturated (PD-FS) sequences, the intact ligament remains hypointense against the background of high-signal fat-suppressed marrow and soft tissues (1, 3). Quantitative studies have established normal UCL thickness ranging from 2.0 to 2.3 mm, which is notably thicker than the radial collateral ligament (1.4-1.5 mm) (1). This dimensional difference reflects the UCL's greater biomechanical role as the primary valgus stabilizer. Knowledge of this normal appearance is essential, as subtle thickening or signal alteration may be the only indicators of low-grade injury (2).

Acute UCL Injury: Characteristic MRI Findings

In acute traumatic settings, MRI demonstrates a constellation of findings that reflect the underlying pathoanatomy. The injured UCL consistently shows poor definition, discontinuity, and heterogeneously increased signal intensity on fluid-sensitive sequences including PD-FS and T2 fat-saturated images (1, 4). This signal pattern corresponds to edema, hemorrhage, and ligamentous disruption. Thickening of the ligament is observed in acute tears, representing a combination of true ligamentous swelling and surrounding inflammatory changes (3). Periligamentous edema is a highly sensitive but non-specific finding that consistently accompanies acute injuries (1, 2, 4). In complete acute ruptures, the gap between torn ligament ends is generally easily identifiable on MRI, with the gap size correlating with the degree of displacement and likelihood of Stener lesion formation (2, 6).

The location of the tear carries important clinical implications. Approximately 90% of UCL ruptures occur at the distal insertion on the proximal phalangeal base, a finding consistently reported across multiple studies (3, 59). This predilection reflects the biomechanical vulnerability of the enthesis region. Tears are classified anatomically as proximal, mid-substance, or distal (5). Notably, sex-related differences in rupture patterns have been demonstrated in a large cohort of 1,582 patients: mid-substance tears occur more frequently in women, while men are more prone to distal ligament or bony avulsions, an effect mediated in part by differences in trauma intensity (59). This observation has clinical relevance for injury mechanism assessment and surgical planning.

Partial Versus Complete Tears: MRI Gradation

MRI provides reliable discrimination between partial and complete UCL tears based on established criteria. In partial (low-grade) tears, the ligament shows abnormal thickening exceeding 7 mm without a fluid gap or complete attenuation, with T2 hyperintense signal involving less than 50% of ligament fibers (5, 5). Moderate to high-grade partial tears demonstrate discontinuity and a fluid signal gap involving 50% to less than 100% of fibers (5, 5). These partial injuries may be managed conservatively with immobilization, though the threshold for surgical intervention varies based on clinical instability (2, 50).

Full-thickness complete tears show disruption through the entirety of the ligament, with either avulsion fractures or complete fluid-filled clefts visible on MRI (3, 5). The presence of a complete tear alone does not mandate surgery; rather, the critical distinction is whether the tear is displaced (Stener lesion) or non-displaced. Non-displaced complete tears may heal with 4-6 weeks of immobilization if the ligament ends remain in apposition (2, 32). MRI's ability to make this distinction with high accuracy is therefore clinically vital.

Stener Lesion: The Pathognomonic MRI Finding

The Stener lesion represents a displaced complete UCL tear in which the torn ligament retracts superficial to the adductor pollicis aponeurosis, preventing spontaneous healing (3, 32). This lesion has a distinctive and highly characteristic MRI appearance described as a "yo-yo on a string," where the proximally retracted ligament stump is visualized with the interposed adductor aponeurosis between it and the insertion site (2, 3). Full-thickness tears with 3 mm or greater

separation between ligament ends raise strong suspicion for a Stener lesion (6). The concept of a "quasi-Stener" lesion, in which partial interposition may occur, has also been described on MRI and may similarly require surgical intervention (6).

Optimal visualization of Stener lesions requires dedicated attention to axial imaging planes. While coronal sequences remain the primary plane for visualizing the overall UCL morphology, axial images are critical for evaluating the relationship between the retracted ligament and the adductor aponeurosis (3, 3). Careful attention to patient positioning to select an axial imaging plane where the metacarpal head appears most rectangular has been recommended to optimize diagnostic accuracy (3). The ability to directly visualize the displaced ligament and its relationship to the aponeurosis represents a significant advantage of MRI over ultrasound for this specific diagnostic task, reflected in the higher specificity of MRI for displaced tears (92% vs 72%, $p < 0.05$) (7).

Chronic UCL Injury: Diagnostic Challenges

Chronic UCL injuries present substantially differently on MRI compared with acute tears, creating diagnostic challenges that clinicians must recognize. Scarring appears as an irregular area of decreased signal intensity on all sequences, and the gap between torn ends is not easily identifiable (2). Excessive scarring and absence of high-signal edema characterize chronic presentations (6). In many chronic cases, particularly among female athletes, MRI may show no significant findings despite persistent clinical instability (5). This paradox—normal-appearing MRI in the setting of symptomatic chronic UCL insufficiency—reflects the predominance of ligamentous laxity and scarring rather than acute inflammation or gross disruption.

For these chronic presentations, clinical examination with stress testing retains a central diagnostic role (26, 41). Ultrasound with dynamic assessment may offer complementary information by allowing real-time visualization of ligament tension and joint stability during provocative maneuvers (8, 41). The limitations of MRI in chronic settings should not be interpreted as a failure of the modality but rather as a reflection of the underlying pathoanatomy: chronic injuries are often characterized by ligamentous attenuation and functional insufficiency rather than morphologic disruption detectable on static imaging (2, 60).

Associated and Secondary MRI Findings

Beyond the primary ligamentous injury, MRI frequently reveals secondary findings that provide additional diagnostic and prognostic information. Bone marrow edema at the proximal phalanx or metacarpal head is commonly observed, reflecting the transmitted forces at ligament attachment sites (3). Bony edema has been reported in approximately 50.6% of patients in analogous elbow UCL cohorts, with parallel findings expected in thumb injuries (5). Avulsion fractures at the ligament attachment sites are well depicted on MRI and may be better visualized than on radiography, particularly when fractures are small or non-displaced (3, 62). Rotation or subluxation at the thumb MCP joint due to altered physiologic forces following ligament disruption may also be identified (11). These associated findings, while not diagnostic of UCL injury themselves, increase diagnostic confidence when present and may explain persistent symptoms following apparent ligament healing.

MRI Imaging Technique: Evidence-Based Protocol Recommendations

The systematic review identified relatively few studies providing detailed MRI protocols specifically for thumb UCL evaluation, but the available evidence supports specific recommendations. A 3-Tesla magnet with a dedicated hand coil is preferred, as higher field strength is associated with improved signal-to-noise ratio and spatial resolution, particularly important for visualizing the small ligamentous structures of the thumb (3, 6). Studies using lower field strengths (0.5-1.5 T) with radiofrequency surface coils have been reported, though image quality is inferior (6, 6).

Coronally oriented images represent the primary plane for visualizing the entire UCL from its metacarpal origin to its phalangeal insertion (2, 3). T1-weighted sequences provide optimal anatomic detail, while fluid-sensitive sequences (PD-FS, T2 fat-saturated) are most sensitive for detecting ligament pathology and surrounding edema (1, 1, 4). Axial images are essential for evaluating the relationship between the UCL and the adductor aponeurosis—the critical finding for identifying Stener lesions (3). Careful attention to positioning to select an axial imaging plane where the metacarpal head appears most rectangular has been recommended to optimize visualization of this relationship (3). Sagittal images may provide complementary information but are not considered essential for routine evaluation (3).

MR arthrography has not been widely advocated for thumb UCL evaluation specifically, unlike its established role in elbow UCL assessment where intra-articular contrast improves detection of partial-thickness tears (10, 24). Standard non-contrast MRI with optimized sequences appears sufficient for most thumb UCL assessments, likely due to the more superficial location of the ligament and the lower prevalence of partial-thickness diagnostically challenging tears (3, 7).

Diagnostic Accuracy of MRI: Pooled Meta-Analytic Data

The diagnostic accuracy of MRI for thumb UCL injuries is exceptionally high and consistently reproduced across multiple studies and meta-analyses. Rashidi et al. reported pooled sensitivity of 99% (95% CI 92-100%) and specificity of 100% (95% CI 87-100%) for diagnosing UCL tears generally (7). Qamhawi et al. focused specifically on Stener lesions and found pooled sensitivity of 93% (95% CI 69-99%) and specificity of 98% (95% CI 70-100%) (6). These values are derived from meta-analyses of high-quality studies using surgical findings as the reference standard. Other primary studies and reviews have reported similar ranges: Madan et al. reported 96% sensitivity and 95% specificity (2); Knisely et al. reported 93% sensitivity and 98% specificity for Stener lesions (3); and Mahajan & Rhemrev reported 96-100% sensitivity and 95-100% specificity (50).

For the specific task of differentiating displaced from non-displaced tears, MRI specificity was 92% (95% CI 73-99%) (7). This performance exceeds that of ultrasound, which demonstrated only 72% specificity for the same distinction (7). This advantage is mechanistically explained by MRI's superior soft tissue contrast resolution, allowing direct visualization of the adductor aponeurosis interposition that defines the Stener lesion (2, 3). The clinical implication is substantial: accurate identification of displaced tears guides appropriate surgical intervention, while non-displaced complete tears may be managed conservatively.

One contrasting report by Morgan & Vaghela (2020) found that MRI demonstrated insufficient sensitivity for clinical use in diagnosing displaced UCL lesions, concluding that neither MRI nor ultrasound achieved adequate sensitivity to obviate surgical exploration (13). However, this was a single-institution experience with a limited sample and likely reflected institutional or methodological factors rather than an inherent limitation of the modality. The pooled meta-analytic

data from larger, higher-quality studies consistently demonstrate excellent MRI performance, and the single contradictory report should be interpreted in that context (6, 7).

Comparison With Ultrasound: Complementary Roles

Both MRI and ultrasound demonstrate high diagnostic accuracy for thumb UCL injuries, and the optimal diagnostic pathway likely involves both modalities in complementary roles (3, 7, 8). For ruling out UCL tears, pooled sensitivities were similarly high for clinical examination (97%), ultrasonography (96%), and MRI (99%), with no statistically significant difference ($p = 0.3$) (7). This indicates that all three approaches are effective for excluding significant injury. For confirming UCL tears, however, MRI specificity (100%) was significantly higher than that of clinical examination (85%, $p = 0.04$) and trended higher than ultrasound (91%, $p = 0.1$) (7). This suggests that MRI provides the highest diagnostic confidence for definitively confirming a tear.

For Stener lesions specifically, ultrasound pooled sensitivity and specificity were 95% and 94% (8), comparable to MRI values of 93% and 98% (6), with ultrasound achieving an area under the curve of 0.98 (8). The comparable performance reflects the fact that both modalities can visualize the displaced ligament stump and its relationship to the adductor aponeurosis, though MRI provides better soft tissue contrast. Several sources advocate ultrasound as an appropriate first-line imaging modality given its high diagnostic accuracy, lower cost, widespread availability, absence of contraindications, and real-time dynamic assessment capabilities (3, 6, 8). MRI is reserved for ambiguous cases where ultrasound findings are equivocal, for surgical planning when a Stener lesion is confirmed, or when clinical and ultrasound findings are discordant (3, 8, 50).

Classification Systems: MRI-Based Grading

Several grading schemes have been applied to thumb UCL injuries using MRI findings, though no universally adopted system exists specifically for the thumb. The most commonly referenced classification distinguishes injuries by severity and location with direct clinical correlation. Grade 1 (sprain/partial tear) shows abnormal thickening (>7 mm), T2 hyperintense signal in $<50\%$ of fibers, and no fluid gap (5); these low-grade injuries are typically managed conservatively (2). Grade 2 (moderate to high-grade partial tear) demonstrates discontinuity with fluid signal gap involving $50\text{--}<100\%$ of fibers (5); these may require immobilization or surgery

depending on stability (2). Grade 3 (complete tear) shows full-thickness disruption with complete fluid-filled cleft or avulsion fracture (3, 5); surgical repair is typically indicated, especially if Stener lesion present (2, 3). The Stener lesion (displaced complete tear) demonstrates the characteristic "yo-yo on a string" appearance with the UCL retracted superficial to the adductor aponeurosis with ≥ 3 mm displacement (2, 3, 6); surgical repair is mandatory as interposed tissue prevents healing (3, 32).

Knott et al. proposed two additional injury patterns specific to American football players, expanding the existing MRI categorization (11). This expanded classification recognizes that specific athletic populations may exhibit injury patterns not captured by conventional schemes. For the elbow UCL—reported by multiple included sources but not directly applicable to the thumb—analogue grading systems classify injuries from intact ligament with edema (grade 1) through partial tearing (grade 2), complete tear (grade 3), and chronic healed injury (grade 4), with grade correlating with valgus laxity and treatment decisions (9, 37, 46). These parallel systems illustrate convergent approaches to MRI-based UCL classification across different joints and support the validity of the thumb-specific classification.

Clinical Implications and Treatment Algorithms

The high diagnostic accuracy of MRI for thumb UCL injuries has direct clinical implications. For acute injuries with suspected complete tear, MRI can definitively identify Stener lesions that require surgical repair (2, 3, 32). The finding of a displaced tear with ≥ 3 mm gap and ligament retraction superficial to the adductor aponeurosis is an indication for operative intervention, as non-operative management will fail due to the interposed tissue preventing healing (3, 6). Conversely, non-displaced complete tears may be treated with 4-6 weeks of thumb spica immobilization, with expected healing rates exceeding 80% (2, 50).

For partial tears, MRI grading guides treatment intensity. Grade 1 injuries (mild partial tears with $< 50\%$ fiber involvement) typically respond to brief immobilization or buddy taping (2, 5). Grade 2 injuries (moderate to high-grade partial tears with $50\% - < 100\%$ fiber involvement) may require more prolonged immobilization or surgical consideration if associated with clinical instability (2, 5). The threshold for surgery in partial tears remains controversial, with some

surgeons advocating operative repair for high-grade partial tears in high-demand athletes while others prefer extended non-operative management (23, 51).

For chronic injuries, the role of MRI is more limited but still valuable. When MRI demonstrates scarring, irregular ligament morphology, or joint subluxation, these findings support the diagnosis of chronic UCL insufficiency and may guide surgical reconstruction (2, 60). However, when MRI is normal in a patient with chronic symptoms, clinical examination with stress testing remains the diagnostic standard, and dynamic ultrasound may provide additional information (26, 41). In such cases, surgical exploration may be indicated despite negative MRI if clinical instability is demonstrated (60, 68).

CONCLUSION AND RECOMMENDATION

Summary of Findings

This systematic review synthesizes the available evidence on MRI manifestations of isolated thumb ulnar collateral ligament injury. The normal UCL appears as a smooth, homogeneously hypointense structure measuring 2.0-2.3 mm in thickness. Acute injuries demonstrate discontinuity, heterogeneous increased signal on fluid-sensitive sequences, and periligamentous edema, with approximately 90% of tears occurring at the distal insertion. Partial tears show thickening >7 mm with T2 hyperintensity involving <50% of fibers, while complete tears demonstrate full-thickness disruption. Stener lesions exhibit a pathognomonic "yo-yo on a string" appearance with the retracted ligament superficial to the adductor aponeurosis.

MRI demonstrates exceptional diagnostic accuracy, with pooled sensitivity of 99% and specificity of 100% for UCL tears, and 93% sensitivity with 98% specificity for Stener lesions. The modality significantly outperforms ultrasound for differentiating displaced from non-displaced tears (specificity 92% vs 72%). Recommended MRI protocol includes 3T magnet, dedicated hand coil, coronal T1 and fluid-sensitive sequences as primary planes, and axial images for Stener lesion assessment. Chronic injuries with predominant scarring and absent edema pose diagnostic challenges, and clinical examination remains important in such cases.

Conclusions

MRI is a highly accurate, non-invasive imaging modality for thumb UCL injuries across the severity spectrum, with particular strength in identifying Stener lesions and differentiating displaced from non-displaced tears. Its superior soft tissue contrast resolution enables direct visualization of the adductor aponeurosis interposition that defines the Stener lesion and guides surgical decision-making. The evidence supports an initial diagnostic pathway of clinical examination followed by ultrasound, with MRI reserved for cases requiring definitive characterization of tear displacement, surgical planning, or when clinical and ultrasound findings are equivocal.

Recommendations

1. **Clinical practice:** MRI should be obtained for all suspected complete UCL tears where surgical management is being considered, as the identification of a Stener lesion is an indication for operative repair.
2. **Imaging protocols:** Institutions should standardize thumb UCL MRI protocols to include coronal T1 and PD-FS sequences, axial images optimized for adductor aponeurosis visualization, and use of 3T magnet with dedicated hand coil when available.
3. **Interpretation:** Radiologists should specifically comment on tear location (proximal, mid-substance, distal), tear completeness (partial vs complete, with estimated percentage of fiber involvement), presence of Stener lesion (with measurement of gap size and relationship to adductor aponeurosis), and associated findings (bone marrow edema, avulsion fractures, joint subluxation).
4. **Chronic injuries:** For patients with chronic symptoms and negative MRI, clinical stress testing and dynamic ultrasound should be performed before concluding that significant pathology is absent.
5. **Future research:** Prospective multicenter studies with standardized MRI protocols and blinded interpretation are needed to confirm diagnostic accuracy in community practice settings. Longitudinal studies correlating specific MRI findings with clinical outcomes

following both operative and non-operative management would strengthen evidence-based treatment algorithms.

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