Tendinopathies about the hand and wrist: A review of MR imaging features

Poster No.: C-2353
Congress: ECR 2010
Type: Educational Exhibit
Topic: Musculoskeletal
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Keywords: Tendinopathies, Hand and wrist, MR imaging
DOI: 10.1594/ecr2010/C-2353

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Learning objectives

To illustrate the MR imaging spectrum of pathologic findings in the tendons and tenosynovial sheaths about the wrist and hand.

Images for this section:

Fig. 1
Background

While MRI is rather a problem-solving tool in the second line behind real-time ultrasound, its high diagnostic accuracy in pathologies of the wrist and finger tendons is undisputed. Moreover, pathologic conditions of the tendons or synovial sheaths do not infrequently cause inexplicable wrist pain. These cases can often be easily resolved by MRI. We reviewed the wrist and hand MRI cases from the last 5 years in our teaching archive and searched them for tendinopathies. A selection will be presented. After a brief survey of the normal anatomy of the tendon compartments and the MRI characteristics of tendinous structures, the terminology of tendinopathies is reviewed.

Anatomy

The human hand is a unique tool in the animal kingdom, which combines strength of grip with high precision. Its anatomic structure allows for a wide range of movement, but also stability. Most of the musculotendinous units that move the hand and fingers traverse the wrist and insert into the metacarpals or the phalanges, thus indirectly controlling the position of the carpal bones. Knowledge of the flexor and extensor mechanisms of the hand and the location of the tendon sheaths is a prerequisite for the interpretation of imaging studies of the wrist and hand.

The long tendons of the hand and fingers are closely applied to the rotation centres of the joints by fibro-osseous tunnels.

Extensor mechanisms

The extensor tendons are held closely to the distal radius and ulna by the extensor retinaculum, a broad fascial band that extends obliquely from the anterolateral surface of the radius across the dorsum of the wrist inserting into the pisiform and triquetral bones, but not directly into the ulna.

The extensor retinaculum covers six fibro-osseous compartments. In each compartment, a single synovial sheath, formed by visceral and parietal layers, surrounds one or more tendons (Fig. 1 on page 8):

* 1. M. abductor pollicis longus, M. extensor pollicis brevis
* 2. M. extensor carpi radialis longus, M. extensor carpi radialis brevis
* 3. M. extensor pollicis longus
* 4. : M. extensor digitorum communis, M. extensor indicis proprius

* 5. : M. extensor digiti minimi

* 6. : M. extensor carpi ulnaris

These nine tendons move towards the middle hand or fingers without any attachment to the carpal bones. Lister’s tubercle, a bony protuberance of the dorsal radius between the second and third compartments, serves as a useful landmark in the identification of the extensor tendons (Fig. 2 on page 8).

In the first compartment, the EPB tendon overlies the radial styloid, more dorsally than the APL tendon. In about one third, there is a fibrous septum between them, splitting the first compartment in two distinct spaces. Accessory tendon slips of the APL tendon occur in about 75% and are usually encountered in a more distal position.

The ECRL and ECRB tendons of the second compartment reach the bases of the second and third metacarpals. The ECRB tendon is located more medially, adjacent to Lister's tubercle. About 4.2 cm proximal to the wrist joint, the tendons of the second compartment are crossed by the muscle bellies of the tendons of the first compartment.

The EPL tendon of the third compartment adopts an oblique course distal to Lister's tubercle and crosses the tendons of the second compartment at the level of the scaphoid. At the base of the thumb, it joins the EPB tendon on its ulnar aspect. Together with the tendons of the first compartment, the EPL tendon forms the anatomical snuffbox.

The fourth compartment encloses the tendons of the EDC for the second through fifth fingers, and the tendon of the EIP, which may be absent in about 40% of cases. If it is present, the EIP tendon is positioned on the ulnar side of the EDC tendon for the index finger. At the level of the middle hand, the EDC tendons are interconnected by juncturae tendinum. Over the distal metacarpal, the extensor tendon expands to form a hood, which covers the back and sides of the MCP joint. The extensor hood is stabilised by the radial and ulnar sagittal bands, a dorsal sling of transverse fibres, that passes palmarward to attach to the volar plate and the transverse metacarpal ligament. The insertion of the extensor aponeurosis consists of three slips, one proximal central, which attaches to the middle phalanx, and two distal lateral, attaching to the distal phalanx.

The fifth compartment, containing the small EDM tendon, is a purely fibrous tunnel, just superficial to the distal radioulnar joint.

The sixth compartment is situated over the ulnar styloid and contains the ECU tendon, which crosses the dorsal surface of the hamate and inserts on the base of the fifth metacarpal. Extension of the fingers is not merely effected by the extrinsic muscles of the forearm. It also involves close cooperation with the interossei and lumbral muscles.
of the hand, as well as stabilising retinacular structures. An overview of the extensor mechanisms is shown by Fig. 3 on page 9.

**Flexor mechanisms**

At the volar wrist, two synovial sheaths traverse the carpal tunnel: The radial bursa, containing the FPL tendon, and the ulnar bursa, containing the FDS and FDP tendons (Fig. 4 on page 10). The radial bursa is always continuous with the tendon sheath of the FPL at the finger level. The FPL tendon passes between the superficial and deep bellies of the flexor pollicis brevis muscle into the osteofibrous canal of the thumb and inserts at the base of the distal phalanx.

The ulnar bursa contains the FDS and FDP tendons and is continuous with the flexor sheath of the little finger in about 80%.

The lumbrical muscles arise from the tendons of flexor digitorum profundus in the palm. They act as main MCP flexors since their tendons pass palmar to the joint axis (Fig. 5 on page 11).

The flexor tendons of the fingers 2-4 are invested by their own separate synovial sheaths beginning at the level of the metacarpal necks. In about 90% of cases, these do not communicate with the ulnar bursa. The pulley system at the long fingers consists of 5 stiff annular and 3 loose cruciate ligaments that form part of the fibrous tendon sheath. The pulleys are numbered from proximal to distal. The odd-numbered annular pulleys (A1,A3,A5) lie over the MCP, the PIP and the DIP. The even-numbered (A2,A4) lie over the proximal and middle phalanx. The latter insert into the bone and are the most important in preventing volar displacement (bowstringing) of the finger flexor tendons.

At the base of the proximal phalanx, the FDS tendon divides into two slips, which encompass the profundus tendon (chiasma of Camper) to insert into the middle phalanx. The FDS of the fifth finger is absent in 30%. The FDP tendon inserts into the base of the distal phalanx. It is the only flexor of the DIP joint.

The flexor tendons of the wrist, the FCR and the FCU, lie in a more superficial position outside the carpal tunnel. The FCR has its own synovial sheath and runs in a fibro-osseous tunnel, which is formed in part by a shallow groove at the ulnar aspect of the trapezium. It inserts into the base of the second metacarpal and may also send a slip to the scaphoid tubercle.

The FCU tendon inserts at the pisiform, which can be viewed as a sesamoid bone in it. From there, it sends fibres to the hook of the hamate and the base of the fifth metacarpal. It is therefore the only extrinsic tendon inserting primarily at carpal bones. Together with the palmaris longus (PL) tendon, it is also the only extrinsic tendon without a synovial sheath.
General tendon pathology

Tendons owe their tensile strength to a framework of 90% highly aligned type I collagen fibres. They also contain elastin, providing compliance and elasticity, proteoglycans as pulse dampeners and lipids, that may reduce shear stress. The epitenon is a white shiny membrane covering the surface of the tendon. In some tendons, it is surrounded by a loose areolar tissue called the paratenon. The paratenon ist typically found in straight tendons capable of elongation due to a high proportion of elastic fibres. It permits free movement of the tendon against the surrounding tissues. Together, the epitenon and the paratenon compose the peritendon.

In most extrinsic tendons of the hand and wrist, the paratenon is replaced by a true synovial sheath or bursa lined by synovial cells. This is referred to as a tenosynovium. From a functional point of view, the tenosynovial unit is designed to transmit maximal loads with minimal energy loss and deformation. Various studies have shown that a healthy tendon is normally stronger than its muscle-tendon junction or even its bony insertion.

However, tendons have weak resistance against shear and compression forces. Injuries from repetitive stress therefore often occur at sites of narrow fibro-osseous tunnels or bony protuberances. Certain sport-related or occupational activities involve repetitive submaximal loading of tendons, resulting in what is referred to as overuse injury. Although there is still some controversy, tendinopathies are commonly classified as follows:

Peritendinitis - inflammation of the peritendon.

Tendinosis - primarily chronic degenerative process of the tendon itself, resulting from repetitive microtraumata and repair mechanisms.

Tenosynovitis - inflammation of the synovial tendon sheath at predilection sites in fibroosseous tunnels.

The term tendinitis as a diagnostic denominator may not be correct, since biopsy studies have been unable to show histologic evidence of inflammation within the tendon substance. Tendinosis may occur alone or in combination with peritendinitis or tenosynovitis. Tenosynovitis can also be caused by primary inflammatory diseases of the synovium, e.g. rheumatoid arthritis (RA). Other systemic illnesses associated with tenosynovitis include diabetes mellitus, crystal arthropathies, and connective tissue disorders. A chronic indolent infection, e.g. tuberculosis, can also mimic benign tenosynovitis. Tendinosis or Tendinitis/Tenosynovitis may eventually proceed to partial or complete rupture of the tendon. Ruptured tendons typically exhibit preexisting degenerative changes on biopsy studies. Spontaneous tendon ruptures are, however, rare, except for RA. Occasionally, tenosynovitis has to be differentiated from masses.
arising in the tendon sheath. The pathology of the tenosynovium in this respect is very similar to that of joints and bursae.

**MR imaging of tendons**

MRI of the hand and wrist has greatly benefited from the use of dedicated surface or quadrature coils. Since most imaging is currently done at 1.5 T, the potential for increase of signal-to-noise at higher field strengths has not been fully exhausted. Parallel imaging with multichannel phased array coils has also made a significant contribution to fine depiction of the intricate anatomy of the tendons and retinacular structures.

MR images of the wrist and hand are obtained in axial, coronal and sagittal planes. T1- and T2-weighted axial images are used in virtually all cases, for they provide most of the information necessary to evaluate pathologies of the tendons, their appendages, and adjacent soft tissues. Sagittal images are very useful for depicting abnormalities of the finger tendons. Coronal planes are obtained mainly at the wrist level. Long-axis STIR may be used to locate pathologic fluid collections or edema along the course of the tendons and their compartments. T2*-weighted gradient echo imaging is preferred to T2 FSE by some authors, because it is more sensitive to pathologies of tendons, ligaments and fibrocartilage. However, it is also more prone to certain artifacts.

When interpreting MR images of the hand and wrist, it must be kept in mind, that tendons may already show enhanced signal in asymptomatic subjects. This holds especially true for the EPL, FPL and ECU tendons and may be explained by normal physiology, anatomical variability, MR artifacts or true tendinosis without clinical importance. However, a fluid rim surrounding a tendon completely, is usually a sign of tenosynovitis. In ambiguous cases, contrast-enhanced T1-weighted imaging may clarify the situation.

MRI is the most reliable non-invasive test to determine the extent of degenerative changes in tendon tissues and differentiate them from partial or subtotal ruptures (Fig. 6 on page 12).

**The magic angle effect**

The observed signal intensity in tendon tissues is dependent on yet another factor, the orientation of the tendon in relation to the main magnetic field (B0). Freely mobile protons in water normally undergo rapid tumbling, which tends to average out dipole-dipole interactions that otherwise can substantially shorten the T2 relaxation time. In collagen-rich tissues with a highly ordered, anisotropic structure, however, the motion and orientation of water molecules is restricted. T2 dephasing due to dipole-dipole interactions is therefore augmented, leading to the typical signal loss of tendon tissues. The dipolar interaction is dependent on the angle between the internuclear vector and the main magnetic field (B0). It vanishes, if this angle becomes 54.74°, commonly rounded to 55°. This is referred to as the "magic angle". Magic angle effects are less apparent on T2-
weighted FSE sequences, because prolonged T2 relaxation times due to the magic angle effect are still much shorter than the echo times (TE) used in these sequences.

As a consequence, distinguishing the magic angle effect from true tendon pathologies requires close comparison of long and short TE sequences. Moreover, the position of the limb in the main magnetic field has to be taken into consideration. At the wrist and hand, the FPL and EPL tendons are especially prone to the magic angle effect, due to their oblique course (Fig. 7 on page 13).

Images for this section:

Fig. 1: Topography of the six wrist extensor sheath compartments beneath the extensor retinaculum. 1. M. abductor pollicis longus, M. extensor pollicis brevis. 2. M. extensor carpi radialis longus, M. extensor carpi radialis brevis. 3. M. extensor pollicis longus. 4. M. extensor digitorum communis, M. extensor indicis proprius. 5. M. extensor digiti minimi. 6. M. extensor carpi ulnaris.
Fig. 2: Topographic cross-sectional anatomy of the extrinsic tendons of the hand and wrist. Abbreviations (clockwise): ECU - extensor carpi ulnaris, EDM - extensor digiti minimi, ED - extensor digitorum communis, EPL - extensor pollicis longus, ECRB - extensor carpi radialis brevis, ECRL - extensor carpi radialis longus, EPB - extensor pollicis brevis, APL - abductor pollicis longus, FPL - flexor pollicis longus, FCR - flexor carpi radialis, PL - palmaris longus, FDS - flexor digitorum superficialis, FDP - flexor digitorum profundus, FCU - flexor carpi ulnaris.
**Fig. 3:** Extensor mechanisms acting on the hand and finger joints. IO - Mm. interossei, LL - Mm. lumbricales, EPL - M. extensor pollicis longus, EPB - M. extensor pollicis brevis, ED - M. extensor digitorum communis, ECRLB - Mm. extensores carpi radialis longus et brevis, ECU - M. extensor carpi ulnaris, APL - M. abductor pollicis longus. Yellow: extrinsic muscles. Blue: intrinsic muscles.
**Fig. 4:** Topography of the flexor tendon sheaths. FCR - M. flexor carpi radialis, FCU - M. flexor carpi ulnaris, FPL - M. flexor pollicis longus, FDP - M. flexor digitorum profundus, FDS - M. flexor digitorum superficialis.
**Fig. 5**: Flexor mechanisms acting on the hand and finger joints. FDP - M. flexor digitorum profundus, FDS - M. flexor digitorum superficialis, FPL - M. flexor pollicis longus, FPB - M. flexor pollicis brevis, LL - Mm. lumbricales, FCR - M. flexor carpi radialis, FCU - M. flexor carpi ulnaris. Yellow: extrinsic muscles. Blue: intrinsic muscles.
**Fig. 6:** Appearance of tendinopathies about the hand and wrist on transverse T1-weighted spinecho and T2*-weighted gradient echo MRI.

<table>
<thead>
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<th>T2*</th>
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<td><img src="image" alt="Tenosynovitis" /></td>
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<tr>
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<td>Complete tear with gap</td>
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**Fig. 7:** Corresponding T2-weighted fat suppressed (left) and T1-weighted (right) coronal images of the flexor tendons. On the short TE sequence, the FPL tendon, oriented at an angle of 55° towards the main magnetic field, becomes isointense to the neighbouring muscle.
Imaging findings OR Procedure details

Examples for overuse syndromes, partial tendon tears or tenosynovitis are given for almost every compartment, from typical cases like De Quervain's tendinitis and rheumatic flexor tenosynovitis to rather rare conditions, like intersection syndrome. The viewer is also confronted with focal fibrotic thickening of the flexor digitorum tendons typically found in the snapping finger, and benign neoplasms of the tendon sheaths, namely giant cell tumour and soft-tissue chondroma. Possible implications of MRI findings are discussed.

DeQuervain's tenosynovitis

Stenosing tenosynovitis of the first extensor compartment is normally diagnosed clinically but may be occasionally encountered when performing MRI for inexplicable wrist pain. It mostly affects middle-aged women between 30 and 50 years and is related to certain activities like typing, piano playing or golf.

Most patients complain of aching pain and swelling over the radial styloid. The pain is aggravated by radial wrist abduction with the fist clenched over the adducted thumb (Finkelstein's test). Thirty percent of patients exhibit bilateral symptoms. The differential diagnosis includes rhizarthrosis or -arthritis, scaphoid fracture, intersection syndrome, and superficial radial nerve compression (Wartenberg's syndrome).

On MRI, increased diameters of the EPB and APL tendons are the most reliable finding. Peritendinous edema is also found in most cases, whereas synovial sheath effusion is present only in the acute phase. Intratendinous signal is not always increased, however, tendon rupture is not an infrequent complication (Fig. 1 on page 20).

In cases with restricted movement or triggering of the thumb, thickening of the extensor retinaculum or nodule formation of the tendons may be found.

Therapy consists of short-time immobilisation and antiinflammatory drugs. Severe cases may require local steroid injection. Operative release of the first compartment and synovialectomy is reserved to cases recalcitrant to conservative treatment. The presence of a vertical septum in the first compartment impedes diffusion of injected steroids and requires opening of both tunnels at surgery.

Intersection syndrome
This type of tenosynovitis may be easily confused with de Quervain's disease, however, it does affect not only the first but also the second extensor compartment. It is caused by irritation of the two radial extensors of the wrist, the ECRL and the ECRB, where they are crossed by the APL and EPB myotendinous junctions. The intersection is located at the dorsal forearm, about 4.2 cm proximal to the radiocarpal joint. Symptoms are triggered by alternating flexion-extension of the wrist, like in wall-painting, weight lifting or rowing (oarsman’s wrist).

Routine MRI of the wrist normally does not include the area of intersection, so the protocol has to be adapted. T1- and T2-weighted transverse sections of the distal forearm and long-axis STIR are the most valuable to assess intersection tenosynovitis. MRI typically demonstrates local soft-tissue edema and tenosynovial fluid at the intersection level and more distally, in the first and second extensor compartments (Fig. 2 on page 21). On rare occasions, inflammation of an intervening bursa may cause palpable or sometimes even audible crepitation (squeaker’s wrist).

Treatment with splints, NSAIDs and local steroids is similar to de Quervain’s. Operative fascial release and excision of the bursa is rarely required.

**EPL tenosynovitis**

EPL tenosynovitis is typically found just distal to Lister’s tubercle where the tendon crosses the second compartment (Fig. 3 on page 22). Although some cases may be caused by overuse related to a biomechanical pulley effect exerted by Lister’s tubercle, there is a history of direct blunt trauma or a (not necessarily displaced) radius fracture in most instances. Tendinitis/tenosynovitis or tendon rupture usually occurs within 8 weeks of the injury, but can occur many years later. EPL attrition tenosynovitis has also been denominated the "distal intersection syndrome". Non-traumatic tears have been described in RA, SLE and gout. Patients present with pain over Lister’s tubercle and, less commonly, local crepitus during thumb movements. EPL and ECRB/ECRL tenosynovitis are strongly correlated due to a communicating foramen between their tendon sheaths. In EPL tenosynovitis, early operative release is advocated due to a high risk of EPL tendon rupture (drummer boy’s palsy). EPL ruptures are not repaired directly, but treated with a tendon transfer, typically using the extensor indicis tendon.

**ECU tenosynovitis**

In ulnar-sided wrist pain, tenosynovitis of the ECU tendon is rarely found as an isolated lesion. It often occurs in RA, which also tends to affect the ulnotriquetral and distal radioulnar joints. Overuse injuries leading to partial or complete tears are typically found in tennis and hockey players. They may occur as a result of instability and mechanical
friction of the tendon against the ulna, secondary to a tear of the retinaculum of the sixth compartment.

MRI may be used to assess the tendon diameter, to identify intrasubstance lesions, and to detect tendon sheath effusion or synovial proliferation (Fig. 4 on page 23), (Fig. 5 on page 24). Chronic ECU tenosynovitis may lead to bony erosions of the ulna. ECU instability may be demonstrated with MRI or ultrasound during forced supination, but the clinical diagnosis with the tendon snapping out of its bed is usually straightforward.

**Extensor digitorum tenosynovitis**

Tenosynovitis of the extensor tendons is a common finding in RA, which often affects more than one compartment. Tuberculous tenosynovitis, which used to be an important cause of EDC tenosynovitis in the past, has nowadays become rare. Extensor tendon ruptures due to tenosynovitis are not uncommon (Fig. 6 on page 25). In advanced RA, dorsal subluxation of the ulnar head may cause sequential attrition ruptures of the EDC tendons from ulnar to radial. This is known to the rheumatologic literature as Vaughn-Jackson syndrome. The EDM tendon is most prone to rupture in a patient with arthritic deformities of the wrist. Aggressive tenosynovectomy has been shown effective to prevent extensor tendon ruptures. Attempts at functional restoration after rheumatic tendon ruptures are rarely successful.

Isolated tenosynovitis of the EIP tendon (EIP syndrome) in non-rheumatic patients is associated with an abnormally distal myotendinous junction of this tendon in 75% of cases.

**Extensor hood injury**

As in EPL tenosynovitis, non-rheumatic inflammations and ruptures of the EDC tendons are mostly caused by trauma.

A predilection site is the MCP joint of the middle finger. Ruptures in the sagittal band of the extensor hood can occur from single or repetitive traumata or forceful hyperflexion of the MCP joint. In most cases, the radial sagittal band is affected, leading to ulnar dislocation of the extensor tendon in the closed-fist position. Laceration of the radial sagittal band causes far more instability than injury to the ulnar side. Associated lesions of the MCP joints are frequently encountered (Boxer’s knuckle). Axial MRI typically shows laxity of the extensor hood at the MCP level and may reveal haematoma or (partial) tendon tears (Fig. 7 on page 26). If performed in closed-fist-position, tendon dislocation to the opposite side of the injury can be demonstrated.

**FCR tunnel syndrome**
Tenosynovitis of the FCR tendon, also termed FCR tunnel syndrome, is not a widely recognised condition. Patients tend be older than 65 years. Volar osteophytes in osteoarthritis of the scapho-trapezium-trapezoid (STT) joint are the most frequent cause. There is inflammation due to constriction of the fibro-osseous tunnel over the distal end of this tendon causing pain on wrist flexion and radial deviation against resistance. FCR tenosynovitis may occasionally lead to irritation of the median nerve. The clinical findings are often misinterpreted as a volar wrist ganglion.

MRI plays a significant role in evaluating these patients, for it it impossible to determine the degree of tendon attrition or visualise significant partial tears with physical exam or ultrasound alone. As it tears, the FCR tendon becomes progressively increased in signal. Proximal to the fibro-osseous tunnel, it may also increase in diameter, and have fluid within its tendon sheath (Fig. 8 on page 27). Therapy is usually conservative, but pronounced bony constrictions may require surgical decompression of the FCR tunnel.

**Flexor digitorum tenosynovitis**

Tenosynovitis of the flexor tendons in the ulnar bursa is the most frequent cause of carpal tunnel syndrome. It is also an early indicator of rheumatoid arthritis. However, a variety of other causes have been described. The MRI diagnosis is based on the presence of T2-hyperintense and T1-hypointense signal surrounding the flexor tendons in the shape of the letter E on transverse images. The signal change is more often due to a thickened synovium than to synovial sheath effusions, as can be demonstrated by additional, contrast-enhanced, T1-weighted imaging (Fig. 9 on page 28).

**Flexor carpi ulnaris (FCU) tendinosis / tendinitis**

Tendinosis of the FCU, resulting from repetitive forced wrist flexion is a common problem in racket sports. Pain is typically located along the FCU tendon and around the pisiform. As the tendon possesses no synovial sheath, there is peritendinitis, but no surrounding effusion on MR images. Acute calcific tendinitis of the FCU has been described as a distinct disease entity, that presents with intense pain, tenderness and erythema along the course of the tendon. The etiology of this genuine inflammatory tendinitis is unknown.

**Tenosynovitis stenosans (Trigger finger)**

Tenosynovitis stenosans of the finger flexors is the most common disorder of the hand and wrist tendons. It mostly affects middle aged women with a high incidence in diabetes mellitus, but can also occur as the end result of chronic mechanical attrition in crafts people or secretaries. Tenosynovitis of the finger flexors may indicate an early stage of
rheumatoid or psoriatic arthritis. The fourth finger is most commonly affected, followed by the thumb and the middle finger. Flexion of the affected finger against resistance becomes painful. The diagnosis is clinically evident, if the finger gets locked in flexed position and snapping occurs with forced or passive extension. However, tenosynovitis without triggering is much more frequent. On MRI, the normal synovial sheath of the finger flexor tendons is usually not appreciable. In acute tenosynovitis, there is an increased amount of sheath fluid. Nodular thickening of the flexor tendons in the vicinity of the A1 annular ligament can be demonstrated by imaging studies in 50\% of cases (Fig. 10 on page 29). Annular ligament cysts (Fig. 11c on page 30) have been described in 33\%.

Cases not responding to conservative therapy are treated by percutaneous release of the A1 pulley. Reduction tenoplasty may be necessary in the nodular type. In the first two fingers, tenosynovitis stenosans must be differentiated from Linberg’s syndrome, a restrictive thumb and index flexor tenosynovitis resulting from straining a variant connection between the FPL and the index FDP tendons at the forearm. Attrition rupture of the FPL tendon caused by a bony spur in the carpal tunnel in RA is referred to as Mannerfelt syndrome.

Masses of the tendon sheath

The vast majority of hand and wrist masses are benign. Many of these have a distinctive appearance on imaging studies, especially MRI. The three most common hand and wrist lesions are ganglion cysts, giant cell tumours, and haemangiomas.

Ganglion cysts

Ganglia are the most frequent space-occupying lesions of the hand and wrist. They are fluid-filled cysts that mostly arise from the joint capsules, to which they are connected by a stalk. In most cases, their lumen has lost communication with the joint. Ganglia of the tendon sheaths are comparatively rare. Typical locations are the common flexor tendon sheath (retinacular cyst) or the annular ligaments of the finger flexor sheaths. On MRI, most ganglia present as thin-walled, often septated cavities, that exhibit water signal in all sequences (Fig. 11 on page 30). However, proteinaceous content of some ganglia may lead to atypical signal characteristics. In symptomatic cases, there may be perifocal edema.

Giant cell tumour

Giant cell tumour (GCT) of the tendon sheath is the second most common soft tissue mass of the hand and wrist. It is a benign lesion that is closely related to pigmented
villonodular synovitis (PVNS) of the joints. GCTs are firm, indolent masses, that may show a locally aggressive behaviour and have a strong tendency to recur after excision.

Signal intensities of GCTs on MRI are low on T1-weighted sequences. On T2-weighted sequences, the tumours typically display inhomogeneous signal with low-intensity areas due to susceptibility effects caused by haemosiderin deposits. After gadolinium administration, there is only moderate enhancement (Fig. 12 on page 31). These MRI signal characteristics are uncommon in other soft-tissue masses and suggest the presence of a GCT.

**Haemangioma**

Soft tissue hemangiomas range among the most prevalent benign soft tissue masses of the musculoskeletal system. They are usually not associated with skin marks, but are rather detected due to their mass effect, mostly in the third decade of life. On MRI, haemangiomas typically exhibit heterogeneous signal, due to variable amounts of vascular and non-vascular tissues. Large soft-tissue haemangiomas often contain fatty tissues, which are easily recognisable due to their high signal on T1-weighted images (Fig. 13 on page 32). Strongly hyperintense signal on long TE sequences with and without fat saturation is characteristic of slow-flowing blood in vascular lacunae of the cavernous type. Phleboliths are best appreciated on T2*-weighted gradient echo sequences. They are considered as pathognomonic for a vascular lesion. Enhancement after contrast administration depends on blood flow dynamics and the possible presence of blood clots. MR angiography can be used to exclude arteriovenous shunting.

**Extraskeletal Chondroma**

Soft tissue chondromas of the wrist are rare, solitary, slowly-growing lesions, that mostly involve the tendon sheaths. Although they do not arise in the bone, they exhibit similar MR signal characteristics to bone enchondromas, including possible calcifications, lobulated contours, and ring-and-arc patterns on T2-weighted and contrast-enhanced T1-weighted images. Large extraskeletal chondromas may lead to cortical bone destructions, making them indistinguishable from malignancies (Fig. 14 on page 33).

**Images for this section:**
Fig. 1: Left: Coronal STIR (a1), transverse T1 SE (a2), and T2* GRE (a3) images in a case of tenosynovitis of the first extensor compartment (DeQuervain's disease). The EPB tendon shows signs of subtotal rupture. Right: Transverse T1 SE (b1) and T2* GRE (b2) MRI in another case of DeQuervain's tenosynovitis demonstrating subtotal tears of both the EPB and APL tendons.
**Fig. 2:** Coronal STIR (a1) demonstrating the intersection of the EPB and APL with the ECR tendons of the second extensor compartment at the distal dorsal forearm. Transverse T2* GRE (a2), and T1 SE (a3) images show massive synovial effusions in the first and second compartments. ECRB - extensor carpi radialis brevis, EPB - extensor pollicis brevis.
Fig. 3: T1 SE transverse and coronal (a1,2) and T2*GRE transverse and coronal sections (a3,4) in a case of posttraumatic tenosynovitis of the second and third extensor compartment. EPL - extensor pollicis longus, ECRB - extensor carpi radialis brevis, ECRL - extensor carpi radialis longus, LT - Lister's tubercle.
**Fig. 4:** T1 SE (a1,2) and T2*GRE (a3,4) transverse sections through the proximal wrist (left) and ulnar head (right). The ECU tendon shows increased intrasubstance signal and peritendinous fluid. There is also an erosion of the ulnar head near the sixth extensor compartment.
**Fig. 5:** Coronal (a1) and transverse (a2) T1 SE, and transverse T2*GRE (a3) images showing a longitudinal split tear of the ECU tendon in a case of rheumatoid arthritis.
Fig. 6: Split tear of the extensor tendon of the second finger after a blunt trauma. On a curved reformatted image of a 3D SPGR sequence (a1), the tendon has an increased diameter (arrowhead). On transverse T1 SE (a2) and T2*GRE (a3), it shows an intrasubstance tear (arrowheads).
Fig. 7: Transverse T2*- (a1), T1- (a2), and contrast-enhanced, fat saturated T1-weighted (a3) images in a case of an acute blunt injury of the ulnar sagittal band of the extensor hood. There is a haematoma between the hood and the MCP capsule and a slight deviation of the extensor tendon to the radial side. Fat saturated T1-weighted (a4) images show an intact central extensor slip. b1 (sag. T1fs+Gd) and b2 (tr. T2*GRE) show a chronic extensor hood lesion with a partial tear of the central tendon slip over the MCP joint.
**Fig. 8:** Coronal STIR (a1) and transverse T1 SE (b1,2)/T2*GRE (b3,4) showing chronic tendinosis and a partial tear of the FCR tendon in its fibro-osseous tunnel (arrowhead, circles). Outside the tunnel (c1,2), there is an effusion in the tendon sheath (arrowheads). Note the bony erosion of the trapezium (b1,3).
Fig. 9: Tenosynovitis of the flexor tendon sheath. Coronal STIR (a1) shows the extent of the inflammation. Native transverse T2*GRE/T1 SE (a2,3) and contrast-enhanced T1-weighted (a4) MRI shows thickening and hypervascularity of the common flexor tenosynovial sheath, caused by rheumatoid pannus tissue.
**Fig. 10:** Sagittal STIR and transverse T1- and T2*-weighted images of the flexor tendon in tenosynovitis stenosans of the middle finger. There is peritendinous edema, increased tendon sheath fluid and nodular thickening of the tendon compared to its neighbours.
**Fig. 11:** a1-3: T1 SE, T2*GRE, and STIR images of a ganglion cyst of the FPL tendon sheath surfacing medially to the FCR tendon. b: Coronal STIR image of a ganglion cyst of the common flexor sheath (ulnar bursa). c1,2: T1 SE and T2*GRE images of an annular ligament cyst of the finger flexor sheath.
Fig. 12: Giant cell tumour of the FPL tendon sheath. Note the low signal in all sequences. a1: Coronal STIR. a2: transverse T2*GRE. a3: transverse T1 SE. a4: transverse T1 SE + Gd.
**Fig. 13:** Musculoskeletal haemangioma involving the FPL and common flexor tendon sheaths and the corresponding musculature of the forearm. a1: Coronal STIR. a2: Coronal T1 SE, a3: Transverse fat saturated T2 FSE. a4: Transverse fat saturated T1 SE + Gd.
Fig. 14: Soft tissue chondroma of the ECU tendon sheath. Coronal T2*-GRE image (a1) showing bony erosions of the wrist and middle hand bones. Transverse T1 SE (a2) and T2 FSE (a3) : The tumour encases the ECU tendon and displaces the EDM and EDC tendons dorsally.
Conclusion

MRI may be used to detect and classify acute and chronic wrist tendinopathies caused by inflammation, single trauma or overuse. It can elucidate the cause of a tenosynovial mass and relate it to the tendon itself or its appendages.

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