Imaging of the hand and fingers with ultrasound has always been challenging. Although the hand and fingers are amenable to ultrasound imaging, the difficulty has been with the small sizes of the anatomic structures under study, as well as the very superficial position of these structures, which places them in the extreme near field of the ultrasound transducer.

However, the development of hand and microsurgery as a subdiscipline of orthopaedic surgery has led to increased demand for imaging of the hand and fingers. Often, the surgeon will have a specific question after the clinical examination, and ultrasound can be directed toward answering this question quickly and easily. As long as the limitations of ultrasound are recognized by both the performing radiologist and the referring clinician, ultrasound will continue to play a large role in hand and wrist imaging.

Clinical Indications

The role of ultrasound in hand and finger imaging is progressively growing. Although much of the current imaging is still based on radiography in terms of traumatic injury and rheumatology, there has been definite recognition of the importance of visualization of the soft tissues, as well as imaging during dynamic movement, both of which are well demonstrated with ultrasound.

Acute hand and finger injuries would still require radiographs as the initial imaging modality, primarily to identify fractures or radiopaque foreign bodies. However, persistent posttraumatic pain or other symptoms in the absence of fracture or bony injury requires further evaluation. Ligament and tendon injuries make up a significant proportion of cases of dysfunction, which are not directly visible on radiographs other than as bony dislocation or subluxation.

Penetrating injuries by foreign bodies are also a frequently encountered indication for ultrasound imaging. It is not uncommon for retained foreign bodies to be nonopaque on radiographs, usually of organic material such as wooden splinters, plant thorn, insect stings, etc. In addition, the foreign bodies may be in multiple small fragments, each of which needs to be identified and removed, to reduce the risk of infection and inciting an inflammatory response. Ultrasound is able to detect such millimeter-sized foreign bodies, providing the hand surgeon with a road map for removal.

Lumps and bumps on the hand have always been a common indication for ultrasound imaging, with the main intention to identify if it is solid or cystic. Ancillary findings would include the relationship or attachment to the surrounding structures, compressibility, vascularity, and location.

The more diffuse swelling in the hand and fingers is usually due to soft tissue edema. The role that ultrasound is able to contribute is to assess if the edema is related to any particular anatomic structure or underlying injury. Joint effusions and fluid collections can also track within the fascial planes and present as swelling. Inflammatory or rheumatologic conditions may also present as joint swelling.

Erosive arthropathy has also become more often imaged with ultrasound, both by radiologists and rheumatologists. Bony erosions demonstrated on radiographs are a late manifestation of disease, and the direct visualization of soft tissue inflammatory pannus with increased vascularity allows earlier detection and diagnosis.

Biopsy, aspiration, or injection of the hand and fingers is easily done by the clinician, knowing the normal anatomy, and with the target area in a superficial location. Ultrasound-guided procedures are occasionally useful in situations where there is an unexpected “dry tap” of a cyst or collection; ultrasound would then be used to both assess if there is sufficient fluid for aspiration, or if the lesion is solid or a diffuse area of soft tissue edema.

Technical Guidelines

With the exception of ultrasound of the skin, the hand and fingers provide the next most superficial body part or organ to be imaged. This by itself demands that high frequency (10 MHz or more) be used to provide adequate resolution. Newer transducers that are commercially available have frequencies up to 17 MHz.

The shape or configuration of the transducer probe is also another matter for consideration. A linear array is a definite requirement, and the two most common forms are the larger (6 to 8 cm width) probes (Fig. 4.1A), or the smaller (2 to 3 cm) “hockey-stick” probe (Fig. 4.1B). The hockey-stick probe is named as such due to its angled head in relation to the handle of the probe. The larger probes allow greater appreciation at any one point due to the larger field-of-view, which is useful in demonstration of the length of a tendon. The hockey-stick probes are easier to manipulate given their...
small size, but that same factor reduces the field of view in any single image. Multiple images or extended field of view imaging is then needed to cover the same area.

One of the disadvantages of standard ultrasound of the fingers is that the finger needs to be fully extended to allow adequate contact with the probe surface. This may not be always possible in patients who have joint deformities, and the finger joints are subluxed or held in fixed flexion. There is also another category of patients who may not be able to straighten the finger due to pain or swelling.

Dynamic assessment of the finger tendons for evaluation of integrity and excursion necessitates active or passive flexion and extension of the metacarpophalangeal and interphalangeal joints. This movement will reduce contact of the finger with the ultrasound probe, precluding accurate and detailed visualization. Usage of liberal amounts of ultrasound gel or a stand-off gel pad or plastic block may be able to overcome these factors, but excessive gel may be messy and the ultrasound stand-off pad or block may be difficult to handle and stabilize.

A water bath was used as the original coupling agent in the early development of medical ultrasound scanning in the 1950s, where the patient was placed into a large container filled with water, and the ultrasound probe mounted on a mechanical arm was moved around the patient. Immersion of the hand and fingers into a small water bath is feasible, and part of the ultrasound probe can also be safely immersed underwater, but not up to the junction of the probe and the cable (Fig. 4.2A,B). This will allow water to act as a coupling medium, and there will be no loss of sound wave transmission even with the finger and the probe not being in direct contact (Fig. 4.2C). The finger can then be placed in various degrees of flexion and extension without loss of sound signal, and dynamic movement and assessment can be performed.

The temperature of the water in the water bath should be tepid or around room temperature, for the comfort of the patient. The water bath should also allow the patient to rest the wrist or forearm, rather than having to hold or suspend it up, which can lead to fatigue or movement.

The ability of cine-loop display, recording, and storage has become more important, in tandem with the development of higher-resolution ultrasound of the hands and fingers. Cine-loop display has been facilitated by picture archiving and communication systems (PACS) or by direct recording via a CD/DVD writer built into the ultrasound unit. Tendon excursion and integrity, in particular, are best assessed with active or passive movement of the fingers. Demonstration of movement assists in distinguishing different anatomic or pathologic structures, given that the gray-scale appearance of many of the normal soft tissues in the hand is of similar echogenicity.

Generally, the most comfortable position for both the patient and examiner is to be seated across the couch from each other. This will allow the patient’s forearm and wrist to rest on the couch, and the wrist can be supported by a small sponge. The hand can then be pronated and supinated easily, to allow ready access and quick examination of all the relevant surfaces. The other advantage is that the patient is usually able to see the ultrasound screen, and the radiologist can then choose to show and explain the relevant images to the patient during or at the end of the study.

Normal Anatomy

Many of the structures in the palm and dorsum of the hand are continuations from the wrist. At the start of the study, it is sometimes better to delineate the anatomy at the level of the wrist, and then trace the structure distally into the hand.
This is because the structures have a more constant position at the level of the wrist, particularly the dorsal extensor tendons, which are divided into six compartments over the distal radius.

**Tendons and Pulleys**

The volar flexion tendons to each finger are composed of both the flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP). Within the carpal tunnel, all the flexor tendons may not be arranged in any specific order, and it is only by tracing the tendons distally to see which finger it is associated with can one identify each tendon with certainty. Within the palm at the level of the metacarpals, the FDS lies superficial to the FDS (Fig. 4.3A,B). The FDP tendon inserts onto the distal phalanx, whereas the FDS tendon divides into two parts at the level of the metacarpal head, (FDP) tendons. At the palm, the FDS tendon (thin white arrow) lies immediately superficial to its corresponding FDP tendon (thick white arrow) (A,B). (Continued)
with each passing around the associated profundus tendon on either side, to wind up deeper than the profundus tendon and attaching on to the base of the middle phalanx. This relationship can be shown on transverse images of the flexor tendons, scanning from proximal to distal (Fig. 4.3C,D).

In the longitudinal plane, the flexor tendons show a fibrillar echogenic appearance, with the FDP inserting onto the distal phalanx (Fig. 4.4). The flexor tendon sheath around each tendon begins in the palm at the level of the metacarpal neck, and follows the tendon distally. Even with the double layer or synovium, it is extremely thin in the normal state and closely apposed to the flexor tendon.

The flexor tendon of each finger passes through the fibro-osseous tunnel, which is formed by the annular and cruciate pulleys, and the palmar cortical surface of the phalanges and palmar plates. The pulleys are condensations of the tendon sheath, and are attached to the adjacent phalanges (Fig. 4.5). There are five annular pulleys designated A1 to A5 and three

**Fig. 4.3 (Continued)** Within the finger, the FDS tendon divides into two (white arrows) and passes around the FDP tendon to end up deep to the FDP before attaching to the middle phalanx (C,D).

**Fig. 4.4** Longitudinal ultrasound (A–C) images and corresponding magnetic resonance (D) image of the normal flexor tendon in the finger (white arrows).
The cruciate pulleys designated C1 to C3, from proximal to distal. The pulleys serve to restrain the flexor tendon, holding it against the phalanges, to prevent bow-stringing on flexion of the finger.

The A1, A3, and A5 pulleys are sited at the metacarpo-phalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints, respectively. The A2 and A4 pulleys are at the level of the midshafts of the proximal and middle phalanges, respectively. The A2 and A4 pulleys are biomechanically the most important, while pathology at the level of the A1 pulley is a common cause of trigger finger.

The course of the flexor tendons are also divided into five zones, which are based on anatomic considerations for tendon injury and repair. The zones are numbered from 1 to 5, from distal to proximal. Zone 1 consists only of the flexor digitorum profundus tendon, at the point distal to the insertion of the flexor digitorum superficialis tendons on the middle phalanx.

Zone 2 extends from the A1 pulley to the level of the middle phalanx, and tendon injury in this region may predispose to formation of adhesions due to the restricted soft tissue space through which the tendons pass. Zone 3 extends from the distal edge of the carpal tunnel to the A1 pulley, and the lumbrical muscles lie in this zone.

Zone 4 includes the carpal tunnel from its proximal to distal boundaries, and zone 5 is from the tendon origins in the distal forearm and wrist until they pass into the carpal tunnel.

The dorsal extensor tendon to each finger is significantly smaller in size than the corresponding flexor tendon (Fig. 4.6). Only the central slip inserts on the base of the middle phalanx, while the two lateral bands pass on either side of the central slip and insert onto the base of the distal phalanx. In the index and little fingers, there are also contributions to the extensor tendon by the extensor indicis proprius and extensor digitii minimi tendons as well.

In the thumb, there are corresponding dorsal and volar tendons that perform extension and flexion. The single long tendon arising above the level of the wrist on the volar side is the flexor pollicis longus (FPL) tendon, which passes within the thenar eminence between the two heads of the flexor pollicis brevis muscle, and inserts into the volar aspect of the base of the distal phalanx (Fig. 4.7).
The three long tendons on the dorsal aspect of the thumb (from radial to ulnar at the level of the wrist) are the abductor pollicis longus (APL), extensor pollicis brevis (EPB), and extensor pollicis longus (EPL) tendons. The APL and EPB lie within the first dorsal compartment at the wrist, pass over a groove on the radial styloid process, and insert on to the base of the first metacarpal (APL) and base of the proximal phalanx (EPB) (Fig. 4.8A). These two tendons form the radial margin of the anatomic snuffbox at the dorsum of the hand.

The extensor pollicis longus tendon lies in the third dorsal compartment of the wrist (Fig. 4.8B). As it passes distally, it hooks around the Lister tubercle on the dorsal surface of the distal radius, runs superficial to the extensor carpi radialis longus and extensor carpi radialis brevis tendons in the second dorsal compartment. It provides the ulnar margin for the anatomic snuffbox, and inserts onto the base of the distal phalanx of the thumb.

Fig. 4.6 Longitudinal ultrasound (A,B) images and corresponding magnetic resonance (C) image of the normal extensor tendon (white arrows) to its distal insertion on the distal phalanx.

Fig. 4.7 Longitudinal (A) and transverse (B) ultrasound images and magnetic resonance (C) image of the flexor pollicis tendon (black arrow) in the thenar eminence.
Muscles of the Hand

The small muscles within the hand can be grouped into the thenar muscles acting on the thumb, hypothenar muscles on the little finger, and the lumbricals and interossei muscles within the palm.

Thenar and Hypothenar Muscles

These consist of the abductor pollicis brevis (APB), flexor pollicis brevis (FPB), opponens pollicis (OP) and adductor pollicis (Fig. 4.9A,C). The abductor pollicis brevis and flexor pollicis brevis muscles lie superficial on the palmar...
aspect, at the level of the first metacarpal bone. The opponens pollicis lies deeper on the radial aspect; the adductor pollicis is on the ulnar aspect. They all insert onto the proximal phalanx, while only the opponens pollicis inserts on the 1st metacarpal. They are all supplied by the median nerve, with the exception of the adductor pollicis, which is supplied by the ulnar nerve.

The opponens pollicis probably has the most important function, which is to oppose the thumb with the other fingers, and also to rotate medially. The ability to oppose provides a myriad of functions of the hand, with the “pinch-grip” allowing us to pick up small objects.

The hypothenar muscles include the abductor digiti minimi (ADM), flexor digiti minimi brevis (FDMB), and the opponens digiti minimi (ODM) (Fig. 4.9B,C). The ADM and FDMB muscle bellies contribute the bulk of the hypothenar eminence, with the ODM lying deep. These are all supplied from the ulnar nerve.

**Lumbrical and Interossei Muscles**

The intrinsic muscles of the hand include the lumbrical and interossei muscles. There are four lumbrical muscles in the palm, and they are unique in the body in that they have no direct bony attachment. They originate from the radial aspects of the flexor digitorum profundus tendons for the first and second lumbricals, and from both the radial and ulnar aspects for the third and fourth lumbricals. They then insert distally onto the lateral bands of the extensor expansion of the fingers, distal to the MCP joints. They are separated from the interossei muscles by the deep transverse intermetacarpal ligament. They function to flex the PIP joints and extend the MCP joints (Fig. 4.10A,C).

The four dorsal interossei muscles are bipennate, with each muscle originating from both of the adjacent metacarpals. Their insertions onto the proximal phalanges are different in each finger, attaching only to the radial aspect of the index finger, both radial and ulnar aspects of the middle finger, and only on the ulnar aspects of the ring and little fingers. This asymmetrical attachment allows abduction and spreading of the other fingers away from the middle finger (Fig. 4.10B,C).

There are only three palmar interossei, which are all unipennate. They arise from the second, fourth, and fifth metacarpals, and insert onto their respective proximal phalanges, on the ulnar side for the index finger and radial side for the ring and little fingers. Their actions result in adduction, bringing the other fingers toward the middle finger.

**Vessels**

The structures of the hand are supplied by the radial and ulnar arteries, which anastomose in the palm, forming the superficial and deep palmar arteries.

The superficial palmar arch is formed by the terminal branch of the ulnar artery and a superficial branch of the radial artery. It gives off three branches that run in between
the second to fifth metacarpals and bifurcate at the web spaces to form the digital arteries to each finger on the radial and ulnar sides. There is also a single branch, which runs on the ulnar side of the little finger.

The deep palmar arch arises from the terminal branch of the radial artery and a deep branch of the ulnar artery. The arch lies slightly more proximal to the superficial arch, at the level of the carpometacarpal joints. The arch gives off branches that contribute to the digital arteries of the fingers, together with the arteries from the superficial palmar arch.

In addition, the radial artery also winds dorsal to the base of the first metacarpal as it enters the palm from the wrist. At this location within the first web space, it gives off the princeps pollicis artery, which continues distally as the digital artery to the thumb. The princeps pollicis artery terminates as the radialis indicis artery, which runs on the radial side of the index finger as the digital artery (Fig. 4.11).

**Joints**

**Carpometacarpal Joints**

**Thumb**

This joint is formed by the concave distal surface of the trapezium and the opposing base of the first metacarpal. The exact bony configuration may vary, but it is primarily a saddle-shaped joint. This allows the joint to have a very wide range of movement, which is particularly useful in opposition of the thumb to the other fingers. As such, the stability of the joint depends mainly on the joint capsule and collateral ligaments.

The ulnar collateral ligament is the strongest ligament in the joint, and extends from the tubercle of the trapezium to the palmar aspect of the base of the first metacarpal. It prevents hyperextension and radial subluxation (Fig. 4.12).

The radial collateral ligament lies on the dorsoradial side of the joint, and lies just proximal to the abductor pollicis longus tendon insertion on the first metacarpal.

Both collateral ligaments blend with the joint capsule, which encases the joint space. The capsule is relatively lax to allow for the wide range of movement. There are other smaller supporting ligaments at the first carpometacarpal joint, but these are usually not discernable with ultrasound.

**Fingers**

The carpometacarpal joints of the fingers form a continuous synovial space extending from the trapezoid-second metacarpal articulation to the hamate-fifth metacarpal articulation. There are short carpometacarpal and intermetacarpal ligaments present.

**Metacarpophalangeal Joints**

The metacarpophalangeal joints are condyloid in configuration, with a convex or flat head at the metacarpal, and a shallow concave surface at the base of the proximal phalanges.

**Fig. 4.11** Longitudinal ultrasound color Doppler image of the normal radialis indicis artery on the radial side of the index finger.

**Fig. 4.12** Longitudinal ultrasound image of the ulnar collateral ligament at the first carpometacarpal joint (white arrow) (A). Corresponding magnetic resonance image (B) of the thumb showing the ulnar collateral ligaments of the first carpometacarpal joint (thick black arrow) and interphalangeal joint (thin white arrow).
Although the main axis of movement is flexion—extension, abduction—adduction with limited rotation is also possible.

The radial and ulnar collateral ligaments have a broad and thick configuration, with the ulnar ligament being stronger than the radial. They originate from the lateral and medial condyles of the metacarpal heads, run distally and in a slightly volar direction to insert onto the palmar surface of the proximal phalanx and adjacent distal portion of the volar plate. Due to this slight obliquity in their course, they are taut in flexion of the MCP joint and slightly lax in full extension.

The fibrocartilaginous volar plate is triangular in the sagittal cross-section, with the thickest central portion measuring up to 3 to 4 mm in size (Fig. 4.13). It has proximal attachments to the palmar surface of the metacarpal neck via the thick radial and ulnar checkrein ligaments, with thinner central band between the checkrein ligaments. The strong distal insertion is onto the cartilage-bone interface at the palmar aspect of the base of the proximal phalanx. Its main function is to provide stability and prevent hyperextension at the joint, and it also merges with the palmar aspect of the joint capsule. There is also a slight groove on the palmar/superficial surface for the adjacent flexor tendon. At the MCP joint of the thumb, there are two sesamoid bones, one each on the radial and ulnar sides of the volar plate. These function as attachments for the thenar muscles.

The joint capsule is lax dorsally with the joint in extension, and there may also be a large proximal bursa. Any significant joint effusion or synovial hypertrophy may be most easily visible on the dorsal aspect. The articular cartilage layer over the head of the metacarpals can be visualized (Fig. 4.14).

**Interphalangeal Joints (Proximal and Distal)**

The interphalangeal joints have a similar appearance and configuration as the metacarpophalangeal joints on ultrasound, with stability provided by the radial and ulnar collateral ligaments, volar plate, and joint capsule in a similar manner. Overall, the interphalangeal joints are smaller in size.

### Pathologies

#### Degenerative

Within the hand, the majority of the joint movement occurs in flexion and extension, with a limited degree of abduction and adduction at the metacarpophalangeal joints. The main exception to this is at the carpometacarpal joint of the thumb. Because of its position and plane of movement set off from the rest of the fingers, as well as the wide range of mo-
tion at the joint, the thumb is able to perform the action of opposition to the rest of the fingers, allowing for a pinch grip and also the development of fine motor skills. This range of movement arises from the saddle-shaped configuration of the joint. However, it also means that there is more stress applied to the first carpometacarpal joint as compared with the rest of the carpometacarpal joints in daily use and function, with resulting degeneration at an earlier age.

Subtle findings may be difficult to visualize, and it is only when there is joint space narrowing, osteophyte formation, and possible subluxation that osteoarthritis of the joint can be confirmed (Fig. 4.15).

Ganglion cyst formation occurs commonly around the hand and wrist, but the actual connection with the joint space may not always be demonstrable on ultrasound. In the hand, ganglion cysts may be associated with the tendon sheath as well. The ganglion should be anechoic with none or minimal septation, and lack of vascularity (Fig. 4.16).

There can also be palpable lesions at the joint margin simulating osteophyte formation. The thumb almost invariably has two sesamoid bones at the first metacarpophalangeal joint, which lie in the flexor tendons. The presence of sesamoid bones at the other metacarpophalangeal joints is not as common, but may present as a palpable lump (Fig. 4.17).

**Inflammatory/Inf ective**

The imaging of rheumatoid arthritis with ultrasound has grown rapidly due to technical advances in small-parts scanning, and its subsequent increase in use of ultrasound by rheumatologists. Many rheumatology clinics have their own ultrasound equipment, and ultrasound imaging of inflammatory joint disease has become an extension of the clinical examination.

Rheumatoid arthritis is probably by far the most common rheumatologic disease studied. One of the more commonly encountered clinical scenarios is a swollen joint in the rheumatoid patient. Ultrasound allows a quick and accurate differentiation between the causes of the joint swelling, which include joint effusion, synovial hypertrophy, and capsular thickening (Fig. 4.18).
At a later stage of the disease, bony erosions are a common feature, which occur due to erosion by pannus. Although the erosions can be visible on radiographs, they are harder to detect in the carpal bones as compared with the metacarpophalangeal and interphalangeal joints. Both ultrasound and magnetic resonance imaging (MRI) have the advantage of allowing cross-sectional imaging in multiple planes, which helps to increase clinical confidence in the diagnosis of carpal bone erosions (Fig. 4.19).

Tendon sheath thickening and tenosynovitis is also part of the rheumatoid disease picture. Assessment on ultrasound is made easier by being able to compare with other normal tendon sheaths in the same hand or the contralateral hand. Color Doppler or power Doppler ultrasound imaging also demonstrates increased vascularity within the thickened tendon sheath, as opposed to tendon sheath fluid, which does not reflect increased vascularity (Fig. 4.20).

Other causes of inflammatory joint disease can be imaged in a similar fashion. However, the features of these are not specific and differentiation of the underlying pathophysiology is usually not possible based on the ultrasound study alone (Fig. 4.21). Inflammatory tenosynovitis can also arise from overuse, in a form similar to De Quervain tenosynovitis, but not being limited to the tendons at the radial side of the wrist (Fig. 4.22).

Crystal deposition disease can also manifest in the hand, with a similar appearance of joint erosion and synovial hypertrophy. However, in gout, the uric acid crystals may manifest with the tendon substance itself, putting the tendon at risk for rupture (Fig. 4.23).
Infection in the hand is usually clinically obvious, given the superficial location and relative lack of soft tissue space to expand. The range of infective change can be imaged, from cellulitis to fluid in the fascial plane to overt abscess formation. Ultrasound can also be used in follow-up to assess for resolution, as well as for complications such as sinus formation (Fig. 4.24). Paronychia at the fingers may also be related to chronic irritation or eczema, or sometimes there

Fig. 4.19 Extensive rheumatoid arthritis affecting the carpal bones of the wrist, with bony erosions seen at the trapezium (white arrows) (A), and vascular flow seen within the overlying pannus (B). Corresponding magnetic resonance images (C,D) show deformity and loss of configuration of the trapezium (black arrow), with smaller erosions in the scaphoid, lunate, trapezoid, and capitate bones (white arrows).

Inflammatory tenosynovitis due to rheumatoid arthritis with a mild degree of tendon sheath thickening (white arrows) (A) and increased vascular flow on power Doppler imaging (B).
can be an underlying cause such as an ingrown fingernail (Fig. 4.25).

**Traumatic**

Traumatic injuries to the hand which require ultrasound imaging usually involve the tendons or ligaments. Bony injuries such as fractures or dislocations would utilize radiographs as a first line of imaging.

Rupture of the extensor or flexor tendons may be due to direct local injury from a laceration or indirectly from sudden muscle contraction (usually against resistance). The

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**Fig. 4.21** Psoriatic arthropathy in the hand showing fluid in the tendon sheath due to tenosynovitis (white arrow) and synovial thickening (black arrow). (Courtesy of Dr. Kok-Ooi Kong.)

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**Fig. 4.22** Extensor tendon tenosynovitis with thickening over the dorsum of the hand in the longitudinal (A) and transverse (white arrows) (B), possibly related to repetitive stress injury.

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**Fig. 4.23** Uric acid crystal deposition (white arrows) eccentrically within the substance of the flexor tendon on longitudinal (A) and transverse (B) ultrasound images, in a patient with known gout.
clinical diagnosis of a complete tendon rupture is usually not difficult, given the history and clinical findings. Where ultrasound plays an important role is to identify and localize the site of the retracted tendon ends, which have an influence on surgical management (Fig. 4.26). This aids the surgeon in planning the site of incision and amount of exposure.

Re-tear of a repaired tendon can also be imaged with ultrasound, although it is comparatively harder to evaluate given the presence of postsurgical change and scarring. However, a complete re-tear can usually be identified with some degree of certainty.

Injury to the collateral ligaments at the metacarpophalangeal and interphalangeal joints are also common (Fig. 4.27). Most of these are managed conservatively and usually by themselves may not require ultrasound imaging. The ulnar collateral ligament of the thumb is occasionally put at risk due to a valgus force applied at the metacarpophalan-

![Fig. 4.24](image1.png) **Fig. 4.24** Persistent discharge from a sinus opening for 4 months after cat bite. Ultrasound (A) shows the sinus opening (between white arrows) under a waterproof dressing. Magnetic resonance imaging (B) shows both the skin sinus opening (white arrow) as well as a deep track (black arrow) leading to the third metacarpal head, which had changes of osteomyelitis (not shown).

![Fig. 4.25](image2.png) **Fig. 4.25** Paronychia of the finger with redness and swelling. Ultrasound in the longitudinal (A) and transverse (B) planes show the portion of the ingrown fingernail (white arrows) as the underlying cause.

![Fig. 4.26](image3.png) **Fig. 4.26** Rupture of the flexor digitorum profundus tendon to the ring finger at the level of the proximal interphalangeal (PIP) joint, with fluid seen in the gap (white arrow).
geal joint of the thumb (gamekeeper’s thumb as originally described, or skier’s thumb in the modern day).

In addition, a complete tear of the ulnar collateral ligament of the thumb may be complicated by interposition of the adductor aponeurosis between the avulsed distal end of the ligament and the base of the proximal phalanx. This is known as a Stener’s lesion, and the interposition will prevent healing of the ligament if surgical correction is not done. Ultrasound can be used to identify a Stener’s lesion.

Ultrasound is also widely used for confirmation and localization of radiolucent foreign bodies in the hand. Penetrating injuries to the soft tissues of the hand and fingers...
are common, as the hand is used in many activities such as catching and grasping; some particular occupations such as gardeners or fishmongers are also at risk. Common foreign bodies include thorns, fish bones, glass fragments, wooden splinters, etc.

The position of the retained foreign body may not lie directly under the site of the skin puncture wound, and any external portion of the foreign body may have been broken off or removed incompletely (Fig. 4.28). Ultrasound is able to directly visualize the foreign body, and to provide information to the number, size/length, configuration and orientation of the foreign body (Fig. 4.29). This will give the surgeon a “road-map” to plan the appropriate surgery.

Ultrasound can also demonstrate the granulation tissue formed in response to the foreign body, if it has been some time since the injury. On occasion, the granulation tissue may be easier to see than the foreign body itself (Fig. 4.30).

The germinal matrix at the nail bed, which produces the nail plate, is also prone to injury, and hypertrophy of either the matrix tissue or granulation tissue can produce swelling or a skin lesion. The external appearance is usually obvious, and ultrasound can assist in delineating the extent and depth of the lesion, in planning for excision (Fig. 4.31).
Posttraumatic or postsurgical scarring can also cause encasement or involvement of the tendons or tendon sheaths. Patients may present with restriction of movement or triggering (Fig. 4.32).

**Tumoral**

Glomus tumors are a benign vascular tumor with a predilection for the fingers. They are thought to arise from the arterial portion of the glomus body, which in the dermis affects temperature regulation. The glomus tumors in the fingers are found in the subungual region or distal pulp of the finger. These may originate from perivascular cells that develop to form the glomus tumor. Their exact etiology is unknown. Patients usually present with exquisite localized pain.

On ultrasound, the glomus tumor is variable in size, and when large, may have pressure effects on the adjacent tissues, nail plate, and distal phalanx (Fig. 4.33). More commonly, they are small (1 to 3 mm) in size, and demonstration...
of these tumors require highly sensitive Doppler color/power imaging. They can be seen as an area of increased vascularity corresponding to the focus of pain (Fig. 4.34).

Giant cell tumor of the tendon sheath (GCTTS) is the second most common tumor found in the hand, only less frequently than the ganglion cyst. They are usually slow-growing and are more common on the volar side than the dorsal side. They may be related to pigmented villonodular synovitis (PVNS), and this may be an extra-articular variant of PVNS.

They are seen on ultrasound as solid, lobulated masses with variable vascularity (Fig. 4.35). On dynamic movement of the finger, they do not move together with their associated tendons.

Benign peripheral nerve sheath tumors are the most often encountered neurogenic tumor in the hand. Neurilemomas or schwannomas arise from the Schwann cells in the myelin sheath, and are usually well encapsulated and slightly lobulated (Fig. 4.36). The normal nerve may be seen within, without separation of the nerve fascicles.
Fibrolipomatous hamartoma is a benign proliferation of perineural and endoneural fibrosis, resulting in thickening of the neural fascicles, interspersed with fatty tissue. The majority occurs in the median nerve, and present with painless swelling, usually without neurogenic symptoms. On ultrasound imaging, the nerve is usually enlarged due to both fascicular enlargement and increased fat deposition within the nerve (Fig. 4.37).

Fibromas are benign condensations of fibrous tissue within the palmar fascia, which may be related to Dupuytren contracture. They have a relatively echogenic appearance on ultrasound due to their high cellularity, and are well defined with no invasive component (Fig. 4.38).

Miscellaneous

There are a large number of normal variants in the hand, often asymptomatic and these do not present for imaging. Ultrasound is well-suited for the first-line examination of any lumps and bumps in the hand, or for a rapid functional assessment of the muscles and tendons.

There can be atypical courses of the tendons on both the dorsal and palmar aspects, as well as anomalous muscle development or insertion (Fig. 4.39).
Suggested Readings


Pearls and Pitfalls

- The use of dynamic movement and its direct visualization with ultrasound is an extremely useful tool, particularly in evaluation of tendon and tendon sheath pathology. It is used both in the identification of normal anatomy as well as to look at abnormal movement of these structures.
- The use of a water bath is a simple and efficient option of maintaining sonographic contact, particularly with flexion of the finger joints and during dynamic movement.
- A good history will go a long way to directing the ultrasound examination to answer the clinical question or problem. It may not be time-efficient to scan every anatomic structure in the hand, or even each finger.
- The choice of an appropriate ultrasound probe is important, as there may need to be a compromise between the larger size of the linear probes, which provide a larger field of view, or the smaller “hockey-stick” probe, which is smaller and more maneuverable.
- The problem of anisotropy is particularly evident with the palmar flexor tendons in the finger, but imaging short segments at a time with proximal or distal tilt of the probe will allow accurate evaluation of the tendons.

Fig. 4.38  Palmar fibroma arising in the plane of the palmar fascia, in between the second and third flexor tendons in the palm (A). No increased vascularity is seen on color Doppler imaging (B).

Fig. 4.39  Diffuse eccentric swelling is due to an anomalous distal insertion of the lumbral muscle seen at the radial aspect of the flexor tendon to the middle finger (white arrows) on longitudinal (A) and transverse (B) images. The patient presented with a form of trigger finger, with inability to achieve full extension.