Diagnostic approach to ultrasound of soft tissues masses in
the hand and wrist

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Learning objectives

1. To illustrate the sonographic characteristics of soft tissue masses in the hand and wrist, and

2. Demonstrate the utility of ultrasonography in the diagnostic work-up of such masses

In this pictorial review, we will outline a diagnostic approach to ultrasonography of hand and wrist mass with images of the various masses to illustrate this as well as additional sonographic characteristics of each mass which will help with their diagnosis. Our aims are to improve knowledge on differential diagnosis of soft tissue masses of the hand and wrist, and demonstrate the usefulness of ultrasonography as a diagnostic tool in the work-up of such cases.
Background

With the improvement in ultrasound technology since its introduction in the late 1940s, ultrasonography has grown to be an indispensable diagnostic tool used to aid physicians in the clinical evaluation of various conditions. Though ultrasonography may be limited in assessing the characteristics of calcifications, ossifications and the characteristics and extent of bony involvement, it remains an excellent tool in the workup of conditions affecting the soft tissue, with the particular advantage of high resolution, dynamic information regarding tendon movement and probe pressure without radiation exposure as opposed to other radiological modalities.¹ On strain elastography, different soft tissue masses have different specific characteristics, and hard masses may suggest a more malignant process than softer ones.²

The majority of soft tissue masses of the hand and wrist are benign,³, ⁴ commonly presenting as a palpable and often incidentally detected mass, that is usually not associated with pain or neuropathy unless there is involvement of adjacent structures.⁵ Ultrasound is therefore frequently preferred by clinicians as an effective, low-cost, portable, non-invasive and efficient means for assessment and diagnosis of such masses.⁶

In the region of the hand and wrist, ganglion cysts are by far the most common of such lesions encountered.⁴ Benign neoplasms include giant cell tumours of the tendon sheath (GCTTS), lipomatous tumours, neurogenic tumours, vascular / peri-vascular tumours, fibromatous tumours and cartilaginous tumours.

Non-neoplastic masses of the hand and wrist include tendon disorders (such as tenosynovitis), articular diseases (such as synovitis and gouty tophi), vascular conditions (such as vascular malformations and aneurysms), post-traumatic causes (such as foreign body granulomas and epidermal inclusion cysts), inflammatory/infective conditions (such as cellulitis and myositis), iatrogenic / post-surgical causes and anatomical variants (such as anomalous muscles).

Malignant tumours in the hand and wrist are relatively rare. These include soft tissue sarcomas (such as pleomorphic sarcoma, rhabdomyosarcoma, liposarcoma, synovial sarcoma and chondrosarcoma), malignant nerve sheath tumours, squamous cell carcinomas and menalomas.
Diagnostic Approach to Imaging Findings

Using US, soft tissue masses in the hand and wrist can be categorised by determining their: nature - solid (hyperechoic or hypoechoic) or cystic (anechoic or hypoechoic), location / relationships, morphology and presence of hypervascularity; supplemented in some cases by lesion consistency as assessed by compression ultrasonography and sonoelastography. The presence of internal vascularity is a helpful finding to distinguish solid hypoechoic from cystic hypoechoic masses. For more complex masses, further imaging with MRI or other non-radiological investigations may be required.

The vast majority of cystic lesions are ganglion cysts. Other cystic masses include aneurysms, psuedoaneurysms and epidermal inclusion cysts. Of the solid tumours, giant cell tumours of the tendon sheath is reported to be the most common. Tendon sheath fibromas and focal nodular tenosynovitis are solid tendon sheath masses that may mimic this tumour. Neurogenic tumours and vascular tumours can be recognised by their relationship to neural and vascular structures, synovial pathology by their location arising from a joint, and glomus tumours by their predilection for the nailbed and presence of hypervascularity accompanied by severe localised pain with point tenderness. Other masses may not be associated with a particular location, but can have specific characteristics that helps with diagnosis. For example, on US, lipomas have homogeneous echoes, thin internal septation, thin-walled capsule and soft elasticity as shown on sonoelastography.

Refer to Fig. 1 for an outline of the approach to US diagnosis of hand and wrist masses.
Fig. 1: Outline of diagnostic approach

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

Imaging characteristics of Soft tissue masses of the hand and wrist.

Ganglion

On US, a ganglion is typically a well-circumscribed, thin-walled, anechoic structure with posterior acoustic enhancement. The mass may be unilocular or multilocular, and internal septations may be seen as fine linear internal echoes. A ganglion usually arises from a joint or from a tendon sheath. For the former, its communication with the joint may be seen as a thin stalk. Colour flow US may or may not show a hypervascular wall with no internal flow. On strain elastography, the mass shows a predominant red to green colour suggesting soft to firm elasticity.
Fig. 2: Ganglion - A) Encapsulated anechoic mass arising from the flexor digitorum profundus tendon sheath of the little finger. B) The mass shows predominantly red to green colour on strain elastography indicating a soft to firm elasticity.

**References:** DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

*Pseudoaneurysm*

On US, a pseudoaneurysm is a cystic mass arising from an artery, that is contained by the surrounding tissue. Duplex US will reveal high flow through the mass, as it communicates with the lumen of the artery. Due to turbulent bidirectional flow, a characteristic "yin-yang" sign may be seen as well, indicating swirling of blood within the pseudoaneurysm.
Epidermal Inclusion Cyst

On US, an epidermal inclusion cyst is a well circumscribed, round or oval-shaped, predominantly hypoechoic mass arising just deep to the skin, with posterior acoustic enhancement. They may have a characteristic pseudo-testis appearance, with bright internal echoes representing debris and anechoic filiform areas. Some lesions may have a connecting anechoic tract to the epidermis (punctum) which can be detected on ultrasound. There is usually no associated hypervascularity on colour flow US. Its appearance may however change from inflammation due to rupture or extension of keratin into surrounding tissue, where there may be less well-defined and lobulated contours, surrounding hypoechoic collections, and increased blood flow in the periphery of the mass.

Giant Cell Tumour of Tendon Sheath

On US, a giant cell tumour of the tendon sheath is a well circumscribed mass which lies in close contact with a tendon. It is a hypoechoic, more often homogeneous mass. Posterior acoustic enhancement may be seen. It is often lobulated and may be seen extending...
along the length of the tendon. Most would show internal vascularity on colour flow US. On dynamic assessment, the mass would not move with the related muscle tendon.\textsuperscript{12}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{Giant cell tumour of the tendon sheath - A) Heterogeneous mixed hyperechoic and hypoechoic mass (star) attached to flexor digitorum profundus sheath (arrow). B) Mass exhibits peripheral and internal vascularity.}
\end{figure}

**References:** DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

**Focal Tenosynovitis**

On US, tenosynovitis is characterised by thickening of the tendon sheath. There may be hypervascularity on colour flow US due to vascular in-growth. In some cases, significant collection of transudate from inflammation can cause distention of the sheath. This produces a "target sign" on transverse images, showing a tendon surrounded by a primarily anechoic collection bounded by the synovial sheath, with posterior acoustic enhancement.\textsuperscript{13}
**Fig. 6**: Tenosynovitis - A) (transverse section) Anechoic fluid surrounding flexor carpi radialis giving a characteristic “target sign”. B) (longitudinal section) Thickened tendon sheath with increase vascularity dorsal to the abductor pollicis longus tendon.

**References**: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

* **Tendon Sheath Fibroma**

On US, a tendon sheath fibroma has similar features to a GCT of the tendon sheath. It appears as a well-defined hypoechoic mass attached to the tendon sheath, often in relation to the annular pulley.\(^{14}\) It usually does not exhibit circumferential involvement of the sheath, and it is less likely to cause adjacent bony changes as compared to a GCT of the tendon sheath, but histology is still required to differentiate the two.\(^{15}\)

![Fig. 6: Tendon Sheath Fibroma](image)

**Fig. 7**: Tendon sheath fibroma - A) (longitudinal section) and B) (transverse section) Well-defined hypoechoic mass with internal septation arising from the volar surface of the flexor tendon sheath, exhibiting posterior acoustic enhancement.

**References**: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

* **Schwannoma**

On US, a schwannoma is typically a well-defined, fusiform, hypoechoic mass that lies in continuity with a nerve, with possible posterior acoustic enhancement, usually affecting the deep nerves of the flexor surface. Entry nerve and exit nerve are characteristically associated with this mass. It may also appear heterogeneous with internal anechoic cystic areas representing cystic degeneration of the schwannoma, and is usually eccentrically located with a tendency to displace the nerve toward the periphery.\(^{14}\) Colour flow US shows variable vascularity.
Fig. 8: Schwannoma - A) (longitudinal section) Heterogeneous, mixed hyper and hypoechoic mass (star) related to right median nerve. Entry and exit nerves can be seen (arrows). B) (transverse section) The mass shows mild internal vascularity.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

Neurofibroma

On US, neurofibromas (NF) are encapsulated, fusiform or oval shaped masses, which usually have a lobulated (macrolobulated or microlobulated) contour. Entering or exiting nerves are seen in about half the cases.\textsuperscript{16} The majority are homogeneous, hypoechoic tumours which show posterior acoustic enhancement, but rarely, neurofibromas are hyperechoic without posterior enhancement.\textsuperscript{17} A target sign or cystic areas within the mass may be seen, and with improvements in colour flow US technology, most neurofibromas will show hypervascularity.\textsuperscript{16, 17}
**Fig. 9:** Neurofibroma - Fusiform, homogeneous, hypoechoic mass with exit nerve seen related to the superficial radial nerve.

**References:** DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

**Fibrolipomatous Hamartoma**

On US, a fibrolipomatous hamartoma appears as a heterogenous mass with hypoechoic thickened axonal bundles interspersed in echogenic fatty tissue, with no intrallesional flow on colour flow US. This is a tumour which arises within peripheral nerves, and commonly affects the median nerve with a predilection for the carpal tunnel. On longitudinal planes, one might see a pathognomonic spaghetti-like appearance with longitudinally oriented cylindrical structures representing nerve fascicles. On transverse planes, one might see a characteristic hypoechoic co-axial cable appearance encased by an echogenic base.
Fig. 10: Fibrolipomatous harmatoma - Tubular hyperechoic mass related to the radial digital nerve traversed by hypoechoic tubular structures representing thickened nerve fascicles giving rise to a "spaghetti-like" appearance on longitudinal section.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

Haemangioma

On US, a haemangioma is a well-defined, compressible, solid mass which is usually hyperechoic due to presence of fat. Serpiginous areas representing dilated vessels may be seen on colour flow US, creating a mixed internal pattern. There is low flow seen on Doppler US without arteriovenous shunting. Hyperechoic foci indicating the presence of phleboliths may be present.
Fig. 11: Haemangioma - A) Heterogeneous mass in the thumb that is generally hyperechoic. B) Mass is hypervascular on colour flow US.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

**Glomus Tumour**

On US, a glomus tumour is a small, rounded, well-circumscribed, homogeneously hypoechoic nodule which is typically subungual or located in the finger pulp. It is typically found by scanning at the site of point tenderness. There may be erosion of underlying phalangeal bone. Colour flow US will reveal hypervascularity of the mass, due to high velocity flow in intratumoural shunt vessels.²⁰

Fig. 12: Glomus tumour - A) Well-defined hypoechoic mass at the base of the nail bed (arrow) causing pressure erosion on the base of the proximal phalanx. B) Internal vascularity is seen.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

**Gouty tophus**

On US, a gouty tophus appears as a heterogeneous hyperechoic mass with poorly defined contours. It is usually found in groups at periarticular areas. A peripheral anechoic halo may be seen,\textsuperscript{21} postulated to be a rim of infiltrates due to inflammation.

This may be associated with other US signs of crystal arthropathy, including hyperechoic cloudy areas within the synovial joint, erosion of joint margins, and a "double contour" sign showing an echogenic line on the outer surface of the joint cartilage parallel to the subchondral bone secondary to crystal deposition.\textsuperscript{22}

\textbf{Fig. 13:} Gouty tophus - Heterogenous hyperechoic mass with poorly defined margins noted at the right middle finger proximal interphalangeal joint.

\textbf{References:} DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

\textbf{Lipoma}

On US, the majority of lipomas are homogeneous masses which may be hyperechoic, isoechoic or hypoechoic, and are usually subcutaneous in location, although they may also be intermuscular or intramuscular in location. They are surrounded by a thin echogenic capsule and often demonstrate thin internal septations. On colour flow US, either absent or mild internal vascularity is seen.\textsuperscript{19}
Fig. 14: Lipoma - A) Homogeneous, hypoechoic mass in the subcutaneous plane on the dorsum of the wrist with a thin echogenic capsule and thin internal septations. B) No internal vascularity is seen.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

Foreign Body Granuloma

On US, a foreign body granuloma presents as a bright echogenic mass centrally, surrounded by a hypoechoic halo with or without increased vascularity on colour flow US, representing a central foreign body surrounded by inflammatory infiltrates. 23

Fig. 15: Foreign body granuloma - A) Linear echogenic foreign body surrounded by hypoechoic soft tissue. B) X-ray shows echogenic foreign body superficial to proximal phalanx of the middle finger.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

Dupuytren's Disease

On US, Dupuytren's disease presents as hypoechoic, fusiform thickening of the superficial palmar aponeurosis, with poorly defined margins and digitations toward
the flexor tendons. Its appearance mimics a supernumerary flexor tendon. Dynamic assessment demonstrating adherence to the flexor tendons and deep surface of the dermis is characteristic of the disease.\textsuperscript{24} It is typically hypervascular on colour flow US. However, old nodules may appear iso- to hyperechoic and without hypervascular colour flow signal.\textsuperscript{14}

\textbf{Fig. 16}: Dupuytren's disease - A) (transverse section) and B) (longitudinal section) Focal hypoechoic mass arising from the palmar fascia superficial to the digital flexor tendons.

\textbf{References}: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

\textit{Anomalous Muscle}

On US, anomalous muscles may resemble soft tissue masses on their short axis, but longitudinal sections show a typical fasciculated muscle structure, with a distinct internal muscular echotexture of fibroadipose septa and muscle fibers. When accompanying a muscle or tendon, active or passive mobilization of the related muscle or tendon during dynamic examination is associated with synchronous contraction of the anomalous muscle.\textsuperscript{1} In the hand and wrist, common anomalous muscles include the abductor digiti minimi, abductor pollicis minimi, palmaris longus, flexor digitorum superficialis indicis, extensor indicis proprius and extensor digitorum brevis manus.
Fig. 17: Anomalous muscle (flexor carpi radialis brevis) - Hypoechoic mass with muscle echotexture (asterisk) just deep to flexor carpi radialis tendon

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

**Squamous Cell Carcinoma**

On US, squamous cell carcinoma manifests as a heterogeneously hypoechoic focal mass with irregular margins. Infiltration into surrounding tissue and erosion of bones may be visualised, and Duplex US may show low-resistance pulsatile flow within the tumour or at its periphery.\(^{25}\) When it occurs in the nailbed, it is often misdiagnosed as a chronic infection or traumatic injury.\(^{26}\)
Fig. 18: Squamous cell carcinoma of the nailbed - A) and B) Diffusely swollen and hypoechoic nailbed with increased vascularity, suggestive of granulation tissue versus focal tumour. C) A hypertrophied ulnar digital artery is seen leading toward the mass. Doppler US shows low resistance flow.

References: DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG

Liposarcoma

On US, liposarcomas are usually heterogeneous, hyperechoic masses with variable appearances, and internal vascularity on colour flow US. These are usually deep-seated tumours which can be intermuscular or intramuscular in location. In contrast to most lipomas, typically, there is nodular septal thickening or a focal, nodular, non-lipomatous region seen as increased heterogeneity of the mass on US, which may or may not have increased vascularity on colour flow US. Note however that imaging is usually inadequate in differentiating liposarcomas from lipomas containing non-adipose foci (reportedly up to 28 - 31% of soft tissue lipomas), and a biopsy is necessary in these cases to rule out liposarcoma.
**Fig. 19:** Liposarcoma - A) Heterogeneous hyperechoic mass in the 3rd inter-metacarpal space extending into the subcutaneous tissue with no definite capsule. B) (T1 MRI) Predominantly high T1 signal in the mass is seen. C) (fat-suppressed T1 MRI post contrast) The central irregular area of low T1 signal shows enhancement post contrast.

**References:** DIAGNOSTIC RADIOLOGY, SINGHEALTH SERVICES, SINGAPORE GENERAL HOSPITAL - Singapore/SG
Fig. 1: Outline of diagnostic approach

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Fig. 2: Ganglion - A) Encapsulated anechoic mass arising from the flexor digitorum profundus tendon sheath of the little finger. B) The mass shows predominantly red to green colour on strain elastography indicating a soft to firm elasticity.

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Fig. 3: Pseudoaneurysm - Colour flow image of vascular mass with a wide neck arising from the radial artery showing characteristic yin-yang flow pattern.

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Fig. 4: Epidermal inclusion cyst - A) (transverse section) and B) (longitudinal section) Subcutaneous mass attached to deep surface of the skin with pseudo-testis appearance and posterior acoustic enhancement.

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Fig. 5: Giant cell tumour of the tendon sheath - A) Heterogeneous mixed hyperechoic and hypoechoic mass (star) attached to flexor digitorum profundus sheath (arrow). B) Mass exhibits peripheral and internal vascularity.

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Conclusion

Ultrasonography is useful as a primary tool for the diagnostic workup of soft tissue masses in the hand and wrist. A sonographic nature and region-based approach to such masses is straightforward and can help clinicians to narrow their differential diagnosis for such masses, and look for specific characteristics to support their suspected diagnosis.

US is sufficient to characterise and as pre-operative evaluation for the majority of soft tissue masses in the hand and wrist. However, US findings can be variable or non-specific at times, and clinical correlation is always important when making a diagnosis. When in doubt, consider MRI to help reach a definitive diagnosis. MRI should also be performed when sonographic findings are suggestive of malignancy to better assess tumour extent and as a baseline for future follow-up.
References


