Radiological approach to focal hand lesions

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Authors: A. A. Tandon, C. H. Lee; Singapore/SG
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Learning objectives

To review the MR imaging findings of various soft tissue lesions in the hand and attempt to classify them into "benign", "intermediate-grade" (histological benign but locally aggressive, with potential for recurrence) and "malignant" lesions.
Background

Soft tissue lesions of the hand are commonly encountered in clinical practice. Though most of them are benign, some form of imaging is usually required to determine their nature. Plain radiography has limited utility but can demonstrate calcification, bony destruction and is able to diagnose some pseudolesions such as arthropathies. Ultrasound can determine cystic or solid nature and tumor vascularity but is inadequate for tissue characterization.

Magnetic resonance (MR) imaging, given its high contrast and spatial resolution, is the imaging modality of choice as it can accurately determine the nature of the neoplasm, its enhancement pattern and relation to surrounding tissues. However, while MR features of various lesions have been well-described, it is often difficult to differentiate between benign and malignant lesions. Location of the lesion in relation to the wrist, metacarpals or phalanges [1], and certain imaging characteristics can aid diagnosis but often histological confirmation is required.

We review the MR imaging features of a variety of hand lesions presenting at our institution and propose a classification into "benign", "intermediate-grade" (histologically benign but locally aggressive with propensity for local recurrence) and "malignant" lesions based on MR findings.

This classification, taking into account certain exceptions, will help in further management of the lesion, pre-operative planning, and in cases of primary malignancy, local staging.
Findings and procedure details

BENIGN LESIONS

1. GANGLION CYST

A 24 year old lady presented with a slowly growing firm painless lump for about 6 months over the left palm. MR is shown in Fig. 1 on page 11. Histological examination showed a cystic lesion with gelatinous material compatible with a ganglion cyst. The most common lump in the hand and wrist is a ganglion cyst [2]. They represent degeneration of connective tissue, and are slightly more common in young female adults. They usually arise from the scapholunate joint and present with a firm lump over the dorsum of the wrist. MR appearance is that of a well-circumscribed cystic lesion although T1-weight signal may vary depending on the amount of proteinaceous material [1].

2. EPIDERMAL CYST

A 42 year-old gentleman presented with a lump over the palm of about 10 years’ duration. MR is shown in Fig. 2 on page 11. Histological examination showed a cystic lesion lined by stratified squamous epithelium compatible with an epidermal cyst. Epidermal cysts result from localised proliferation of epidermal cells within the dermis. They can be congenital, or a result of follicle occlusion by inflammation or tumour, or associated with human papilloma virus infection, or from implantation of epithelial squames into the dermis from trauma [3]. MR features are that of a cystic lesion, although signal can vary depending on amount of internal keratin debris [4].

3. FIBROMA OF TENDON SHEATH

A 51 year-old lady presented with a 6-month history of a lump in the left hand thenar eminence. MR is shown in Fig. 3 on page 11. Histological examination showed collagenous stroma with spindled fibroblasts and slit-like vascular channels compatible with fibroma. Fibroma of the tendon sheath is thought to be a reactive fibrosis and occurs in the hands and wrist in up to 82% of cases [5,6]. On MR, most are of low signal on T1w and T2w sequences, reflecting presence of fibrous tissue. It is thought that fibroma of tendon sheath and giant cell tumour of tendon sheath (GCTTS) represent two endpoints of single clinicopathological entity, with former being the end and sclerosing stage of giant cell tumour of tendon sheath, probably consequential to progressive vascular impairment [7]. On imaging, fibroma and GCTTS can be differentiated using GRE-sequence, the latter usually demonstrating susceptibility from hemosiderin deposits.
4. FOCAL NODULAR SYNOVITIS

A 62 year-old gentleman presented with a painless lump over the dorsal aspect of the right middle finger. MR is shown in Fig. 4 on page 12. Histological examination showed fibrohistiocytic cells, foamy macrophages, multinucleated giant cells amidst hyalinized stroma compatible with focal nodular synovitis. Focal nodular synovitis commonly occurs around the small joints of the hands and feet. They represent the localized form of pigmented villonodular synovitis [8], which usually occurs around the larger joints particularly the knee. Histologically, focal nodular tenosynovitis is also similar to GCTTS, however the lack of susceptibility on GRE-sequence distinguishes focal nodular synovitis from GCTTS [9].

5. NODULAR FASCIITIS

A 39 year-old lady presented with an enlarging painful left wrist lump over 2 months. MR is shown in Fig. 5 on page 13. Histological examination showed an encapsulated lesion with central zone of dense collagen and myxoid areas and peripheral zone of myofibroblasts and spindle cells. Degree and distribution of myxoid and fibrous components within the lesion account for the variable T2 characteristics on MRI. The lesions with high cellular content or myxoid degeneration appear hyperintense on T2-weighted images while those with highly collagenous contents are hypointense. Nodular fasciitis which is most commonly seen in the upper extremity of young adults, almost never recurs after excision [10]. Due to rapid growth and variable MR appearance, these lesions are often misdiagnosed as sarcomas [11, 12].

6. LIPOMA

A 60 year-old gentleman presented with swelling over the first web space of the right hand of 1 year duration. MR is shown in Fig. 6 on page 14. Histological examination confirmed a lipoma. Lipomas are the most common tumour in the human body. On ultrasound, they usually appear as an echogenic lesion with a thin capsule and fine linear internal echoes [13]. On MR they are hyperintense on both T1- and T2-weighted sequences, with homogeneous signal loss on fat-saturation sequences. Amorphous T2 signal intensity areas, thick septa or enhancing areas should raise suspicion of an atypical lipomatous tumour or a well-differentiated liposarcoma [14].

7. LIPOFIBROMATOUS HARMATOMA
A 45 year-old gentleman presented with a lump of 1 year's duration in the first web-space of the left hand. MR is shown in Fig. 7 on page 15. Intra-operatively, a vascular component arising from the princeps pollicis artery was seen within the lesion which was also closely related to the ulna digital nerve. Imaging and operative findings were suggestive of a lipofibromatous hamartoma. Lipofibromatous hamartoma is a rare benign tumour of the peripheral nerves, usually involving the median nerve [15]. Excessive fibroadipose tissue proliferates along the perineurium, surrounding the nerve bundles within the nerve sheath. This gives almost pathognomonic MR appearance of an enlarged nerve with "spaghetti" or "cable"-like appearance on MR, representing the low-signal axons surrounded by fatty tissue [16].

8. VASCULAR LESIONS

A 32 year-old lady presented with a soft lump along the medial aspect of the right hand palmar aspect, with occasional pain. MR is shown in Fig. 8 on page 15. Histological examination confirmed a hemangioma. Hemangiomas are typically multilobulated with high T2w signal, saccular or serpentine vascular spaces seen as flow voids, and may demonstrate fluid-fluid levels with intense enhancement [17].

Another patient, a 32 year-old lady presented with a slowly-enlarging lump over the palm between the second and third metacarpals. Ultrasound and MR are shown in Fig. 9 on page 16. Histological examination confirmed a partly-thrombosed pseudoaneurysm. Aneurysms or pseudoaneurysms in the hand are rare, usually secondary to intimal injury, arterial punctures or arteriovenous shunts for dialysis [18]. Imaging features are suggestive. Arterial Doppler flow is demonstrated on ultrasound. On MR, lesions are usually T1- and T2-hyperintense with areas of GRE susceptibility and high vascular flow void [19]. Avid enhancement is usually seen, but may be variable if thrombus is present.

9. SCHWANNOMA

A 40 year-old gentleman presented with a 15 year history of swelling over the right palm hypothenar eminence, associated with sharp pains and paresthesia. MR is shown in Fig. 10 on page 17. Histological analysis showed spindle cells with wavy band nuclei and rare Verocay bodies diagnostic of schwannoma. Schwannomas are fairly common benign tumours of the peripheral nerve sheath. On MR, schwannomas show low-to-intermediate T1-signal and high T2-signal with homogeneous contrast-enhancement. "Split-fat sign" (peripheral rim of perineural fat compressed by tumour) and the "fascicular sign" (central small ring-like structures representing nerve fibres) may suggest the diagnosis [1].
INTERMEDIATE-GRADE LESIONS

1. NEUROFIBROMA

A 53 year-old gentleman presented with left thumb nailbed swelling of 4-5 years duration. MR is shown in Fig. 11 on page 17. Intra-operatively the nodule was found to originate from a branch of the radial digital nerve. Histological examination showed spindle and stellate cells embedded in a loose fibromyxoid stroma, staining positive for S100 favouring a neurofibroma. Superficial neurofibromas are usually T1-iso-to-hypointense to muscle and heterogeneously T2-hyperintense. Low signal areas indicate collagenous component. A target-sign appearance (central low signal with surrounding high signal on T2-weighted sequence) and central enhancement have been described [20].

2. DESMOPLASTIC FIBROBLASTOMA

A 40 year-old lady presented with a 3-month history of painless swelling over dorsum of the first webspace of the right hand. MR is shown in Fig. 12 on page 18. Histological examination revealed a hypocellular, collagenous tumour with scattered fibroblasts and myofibroblasts compatible with desmoplastic fibroblastoma. These are rare tumours, thought to be related to fibrous proliferation secondary to trauma [21]. MR imaging reveals prominent low signal on all pulse sequences with minimal post contrast enhancement suggestive of low vascularity of tumour [22]. Unlike desmoid-type fibromatosis to which it resembles, desmoplastic fibroblastoma is less infiltrative and does not cause bone erosions.

3. GIANT CELL TUMOR OF TENDON SHEATH

A 23 year-old lady presented with a 1-year history of right thumb swelling and mild pain. Plain radiograph and MR are shown in Fig. 13 on page 19. Histological examination revealed mononuclear and multinucleated giant cells with focal hemosiderin deposition compatible with a giant cell tumour of tendon sheath (GCTTS). GCTTS are typically found in the hands or feet. They are commonly associated with degenerative joints, and thought to be reactive to adjacent inflammation rather than true neoplasms [23]. Plain radiographs show pressure changes in the adjacent bone in 10-20% of cases [24]. On MR the lesion is predominantly low signal on T1w and T2w sequences, usually related to joint and tendon, with susceptibility on Gradient-Echo sequence (GRE) indicating hemosiderin deposition [25].

4. GLOMUS TUMOUR
A 30 year-old presented with a painful lump at the tip of the left ring finger. Plain radiograph and MR are shown in Fig. 14 on page 19. Histological examination showed nests of cells separated by fibromyxoid stroma staining positive for smooth muscle actin (SMA), confirming a glomus tumour. Glomus tumours are common benign lesions resulting from disordered proliferation of the neuromyoarterial apparatus that serves to regulate skin circulation [26]. Useful distinguishing features on MRI is its characteristic subungual location, pressure erosion of underlying bone, very high signal on T2w sequence, and intense enhancement [27].

**MALIGNANT LESIONS**

1. **UNDIFFERENTIATED PLEOMORPHIC SARCOMA**

   A 50 year-old lady presented with a 3-month history of a firm, fixed, enlarging lump over the hypothenar eminence of the right hand. MR is shown in Fig. 15 on page 20. Histological examination showed spindle and epitheloid cells with multiple mitoses, staining positive for vimentin, desmin, and S-100, confirming a high-grade pleomorphic sarcoma. Undifferentiated pleomorphic sarcoma is the most common soft tissue sarcoma in adults. This tumor commonly arises from undifferentiated mesenchymal stem cells, usually in the soft tissues of the retroperitoneum and proximal extremities [28]. MR is imaging modality of choice for local staging. The tumour is typically low to intermediate signal on T1w and intermediate to high signal on T2w sequences. Appearance may vary depending on calcification, fibrous tissue, hemorrhage or necrosis. The tumour is often well-defined despite its malignant nature, due to a pseudocapsule.

2. **PRIMARY SKIN CANCERS**

   An 84 year-old lady presented with short history of diffuse swelling over the base of the right thumb associated with ulceration. MR is shown in Fig. 16 on page 21. Histology showed sheets of polygonal tumour cells and keratin pearls compatible with squamous cell carcinoma (SCC). Primary SCC occurs most commonly in the skin exposed back of hands [29]. Diagnosis is usually suspected clinically and imaging is utilised for local staging.

   A 76 year-old, presented with a focal ulcerating skin lump along the radial aspect of the right thumb base. MR is shown in Fig. 17 on page 22. Histological examination revealed a basal cell carcinoma.
On MR, primary skin cancers are locally infiltrative as illustrated in these two cases. When a superficial tumor has its epicenter in the cutaneous layer and has irregular, infiltrative appearance primary skin malignancy should be suspected.

### 3. BONY METASTASIS

A 67 year-old gentleman with a history of adenocarcinoma of the lung presented with 2-week history of swelling and pain over the medial aspect of the right hand dorsum. Plain radiograph and MR are shown in Fig. 18 on page 23. Imaging findings were highly suspicious for metastasis given the clinical history. Osseous metastases to the bones of the hand (acrometastasis) are uncommon. Acrometastases usually indicate a poor prognosis [30]. Treatment is palliative but can improve quality of life.

### 4. FIBROSARCOMA OF TENDON SHEATH

A 47 year-old lady presented with focal swelling along the ulna aspect of the right wrist, gradually increasing in size over a few months. Ultrasound and MR are shown in Fig. 19 on page 23. Histological examination revealed spindle cells arranged in fascicular fashion with mitotic activity in a background of markedly fibrotic-sclerotic stroma, suggestive of a low-grade fibrosarcoma. Fibrosarcoma of the tendon sheath is rare and is composed of fibroblasts and collageneous matrix. On MR, the lesion is typically of low T1w and T2w sequences, but may have high T2w-signal areas from necrosis. A "spoke-wheel" pattern of enhancement has been described [31].

### PSEUDO-MASSES

1. A 50 year-old lady presented with a painless mobile lump over the lateral aspect of the palm. Ultrasound and MR are shown in Fig. 20 on page 24. Histological examination favoured a benign fibrosclerotic lesion or cutaneous inflammatory pseudotumour. These are rare lesions of unknown etiology [32]. MR findings are usually that of low signal on both T1-weighted and T2-weighted sequences with variable enhancement. This entity has been described to encompass a spectrum of histological appearance from the early, inflammatory lesions, to the chronic sclerotic ones [33].

2. A 60 year old gentleman presented with 6-month duration of gradual swelling along the ulna aspect of the left wrist. Plain radiograph and MR are shown in Fig. 21 on page 25, compatible with gouty arthropathy. Plain radiograph of gouty arthropathy typically shows juxta-articular erosions with overhanging edges, usually associated with a calcified soft...
tissue mass. Characteristic MR appearance is that of a low-to-intermediate signal mass on all MR sequences due to presence of calcification, with peripheral enhancement [34].

3. A 24 year old lady presented with 1 month duration of swelling along volar aspect of the left index finger with pain and loss of flexion. MR is shown in Fig. 22 on page 26, confirming a tenosynovitis.

4. A 70 year old presented with progressive painful swelling over the dorsal aspect of the right wrist over a year. Plain radiographs and MR are shown in Fig. 23 on page 27, compatible with erosive arthropathy.
**Fig. 1:** Ganglion cyst. MR shows a smooth, well-circumscribed lesion within the thenar musculature of homogeneous low signal on T1w sequence (A, arrow) and high fluid signal on T2w-FS sequence (B, arrow). No invasion into adjacent structures is seen. There is minimal rim-enhancement (C, arrow).

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**Fig. 2:** Epidermal cyst. MR shows a smooth well-circumscribed subcutaneous lesion superficial to the thenar musculature with low signal on T1w (A, arrow) and high fluid signal on T2w-FS sequence with faint low-signal foci within representing squames / debris (B, arrow). Minimal rim-enhancement is seen with no significant internal enhancement (C, arrow).

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**Fig. 3:** Fibroma of the tendon sheath. The mass appears mildly hyperintense to skeletal muscles on T1 (a) and T2-weighted fat saturated (b) images. Areas of low signal intensity within the lesion (orange arrows) are attributable to the collagenous nature of the tumor. The mass shows mild post contrast enhancement (blue arrow) on axial T1-weighted fat-suppressed image (c). No susceptibility changes are noted on the gradient image (d).

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Fig. 4: Focal nodular synovitis. MR shows a lobulated subcutaneous nodule of homogeneous low T1w signal over the dorsal aspect of the third metacarpophalangeal joint abutting underlying extensor tendon (A, arrow). The lesion is also of low signal on T2w-FS sequences (B, arrow). No bony destruction is seen. There is no significant contrast enhancement (C, arrow).

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**Fig. 5:** Nodular Fasciitis. a) MRI T1 axial image shows a well circumscribed lobulated mass of intermediate signal intensity along the volar aspect of wrist in close relation to the flexor carpi ulnaris tendon sheath (orange arrow). The mass also abuts the flexor retinaculum (blue arrow) though there is no infiltration of flexor tendons lying deep to it. It shows heterogeneous high signal on (b) T2 (F/S) axial image. Intense enhancement is seen on (c) T1 post contrast image with an irregular non enhancing area within it. No susceptibility is detected on the (d) gradient-echo sequence which may help in differentiating it from giant cell tumor of the tendon sheath.

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**Fig. 6:** Lipoma. MR shows a well-circumscribed lobulated subcutaneous lesion over the palm, hyperintense on T1w sequence crossing compartments, insinuating between the flexor tendons (A, arrow). There is homogeneous signal loss on T2w-FS sequence (B). Faint enhancement of thin internal septae is noted (C, arrow).

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**Fig. 7:** Fibrolipomatous harmatoma. MR shows a well-circumscribed lobulated subcutaneous lesion within first webspace, hyperintense on T1w sequence with curvilinear internal signal voids (A, arrow). On T2-FS sequence the lesion shows homogeneous signal loss with hyperintense curvilinear structures coursing through the centre of the lesion (B, arrow). These structures show enhancement (intra-operatively confirmed to represent neurovascular components of the lesion) while the rest of the lesion does not show significant enhancement (C, arrow).

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Fig. 8: Hemangioma. MR shows a lobulated subcutaneous lesion superficial to the hypothenar muscles, slightly hyperintense on T1w sequence, crossing compartments and insinuating between adjacent flexor tendons (A, arrow). The lesion is very hyperintense on T2w-FS sequence with areas of signal voids (B, arrow) and there is also suggestion of fluid-fluid level (B, arrow). Susceptibility is seen on GRE sequence (C, arrow). Post-contrast there is near-homogeneous enhancement (D).

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Fig. 9: Aneurysm / pseudoaneurysm (partly-thrombosed). Ultrasound shows a heterogeneous lesion with central echogenic material and peripheral turbulent arterial flow on Doppler (A). MR shows a lobulated subcutaneous lesion slightly hyperintense on T1w sequence (B, arrow), lying between the flexor tendons of the index and middle fingers (B, arrowheads). It is extremely hyperintense on T2w-FS sequence with central signal void (C, arrow), corresponding to susceptibility on GRE sequence (D, arrow). Post-contrast there is intense serpinginous enhancement through the lesion (E, arrow).

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Fig. 10: Schwanomma. MR shows a smooth well-circumscribed nodule within the hypothenar musculature iso-intense to adjacent muscle on T1w sequence (A, arrow). On T2w-FS sequence the lesion shows a typical target-sign appearance with hypointense centre with peripheral hyperintense rim (B, arrow). Mild, near homogeneous enhancement is seen (C, arrow).

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**Fig. 11:** Neurofibroma. MR shows a lobulated soft tissue nodule at the tip of the thumb, isointense on muscle on T1w sequence (A, arrow), heterogeneously hyperintense on T2w-FS sequence (B, arrow), crossing compartments to cause bony pressure erosion of the distal phalanx (B, arrowhead). Homogeneous contrast-enhancement is seen (C, arrow).

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**Fig. 12:** Desmoplastic fibroblastoma. MR shows an lobulated mass within the first dorsal interossei muscle of heterogeneously low signal on both T1w (A) and T2w-FS sequences.
(B), with loss of surrounding fat planes. There is heterogeneous enhancement (C, arrow), and the lesion is seen to cross compartments to abut the index finger extensor tendon (C).

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Fig. 13: Giant cell tumour of tendon sheath. Plain radiographs show well-defined lucency at the head of the first metacarpal (A). MR shows a lobulated subcutaneous lesion of intermediate T1w signal (B), crossing compartments to cause bony pressure erosion at the first metacarpophalangeal joint. It is inseparable from the flexor pollicis longus tendon (B, orange arrow) and of heterogeneous intermediate-to-high signal on T2w-FS sequence (C). Areas of susceptibility on the GRE sequence (D). There is near homogeneous avid enhancement (E).

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Fig. 14: Glomus tumour. Plain radiograph shows well-defined scalloping along the ulnar aspect of the left ring finger distal phalanx (A, arrow). MR revealed a smooth, well-circumscribed subcutaneous lesion crossing compartments to cause bony pressure erosion at the tip of the finger. It is of intermediate signal on T1w sequence (B, arrow), extremely and homogeneously hyperintense on T2w-FS sequence (C, arrow). Homogeneous enhancement is seen (D, arrow).

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Fig. 15: Undifferentiated pleomorphic sarcoma. MR shows an irregular mass, hypointense on T1w sequence infiltrating hypothenar musculature crossing compartments to involve flexor tendons of the little and ring finger (A, arrowhead) and overlying skin (A, arrow). It is heterogeneously hyperintense on T2w-FS sequence (B, arrow). There is heterogeneous enhancement (C, arrow).

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**Fig. 16**: Squamous cell carcinoma. MR shows infiltrative circumferential skin and subcutaneous soft tissue thickening around the thumb metacarpophalangeal joint of low signal on T1w sequence (A, orange arrows). There is involvement of extensor pollicis brevis and abductor pollicis brevis (C, blue arrows) with erosion of underlying bone. The lesion is intermediate heterogeneously hyperintense on T2w-FS sequence (B), with heterogeneous contrast enhancement (C).

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**Fig. 17:** Basal cell carcinoma. MR shows an irregular, ill-defined exophytic skin lesion at base of thumb, of intermediate signal on T1w sequence (A, orange arrows) and heterogeneously hyperintense on STIR sequence (B). Heterogeneous enhancement is seen extending to subcutaneous layer (C, blue arrows), but there was no bony destruction.

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**Fig. 18:** Metastasis. Plain radiograph shows permeative destruction of the fifth metacarpal (A). MR shows destruction of the fifth metacarpal with infiltrative soft tissue, predominantly of intermediate signal on T1w sequence (B), heterogeneously hyperintense on T2w-FS sequence (C). Heterogeneous enhancement is seen (D).

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Fig. 19: Low grade fibrosarcoma of tendon sheath. MRI reveals a relatively well circumscribed ovoid mass in the ulnar aspect of the right distal forearm, located primarily in the subcutaneous plane. It lies in close proximity to the flexor carpi ulnaris tendon (blue arrow), with no clear fat plane seen between the two. This lesion is predominantly of low signal intensity on (a) T1W and (b) T2W images with heterogenous area of bright T2 signal (orange arrow). (c) On T1 fat saturated post contrast image, the lesion appears very vascular and shows mildly heterogeneous enhancement. Dark linear strands are also seen on T1, T2W and post contrast images which suggest fibrous nature of the lesion. (d) On ultrasound which is inadequate for tissue characterization, the lesion appears isoechoic. The flexor carpi ulnaris tendon lies deep to it (arrow).

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Fig. 20: Benign inflammatory fibrosclerotic lesion (pseudotumor). (a) T1 axial image shows an intermediate signal intensity lesion overlying the 4th metacarpal. (b) On T2 (F/S) axial image the lesion reveals hypo to intermediate signal intensity. The lesion is closely related to the palmar interosseous muscle of fourth webspace but remains separated from the flexor tendon sheath by clear fat plane. (c) On colour doppler ultrasound study, the lesion appears iso to hypoechoic and demonstrates vascularity. The flexor tendon is seen deep to it.

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**Fig. 21:** Gouty tophus. Plain radiograph shows amorphous calcification adjacent to the ulna styloid (A, arrow). MR shows an irregular, subcutaneous lobulated mass of low signal on STIR (B, arrow) and T2w-FS sequences (C, arrow). Mild peripheral enhancement is seen (D, arrow). Erosions of the underlying bone are also seen (D, arrowhead).
Fig. 22: Tenosynovitis. T1w (A, arrow) and STIR sequences (B, arrow) show thickening and edema of the index finger flexor tendon sheath. Diffuse enhancement of the sheath is seen (C, arrow).

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**Fig. 23:** Erosive arthropathy. Plain radiograph shows narrowing and sclerosis at the radiocarpal joint, osteophytes, loose bodies (A, arrow). T1w (B) and T2w-FS (C) MR sequences (C) show synovial thickening, subchondral erosions along the carpal bones and small effusion at the distal radio-ulna joint. Marked synovial enhancement is seen (D, arrow).

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Conclusion

We propose a classification of hand lesions in our review (excluding pseudo-masses) into "benign", "intermediate-grade" (histologically benign but locally aggressive with potential for recurrence) and "malignant" lesions (Table 1). This is based on MR signal on T2-weighted images, enhancement pattern, lesional margins, presence of bony destruction, and whether the lesion extends across compartments (cutaneous, subcutaneous, muscular, bony, neurovascular, extensor, flexor compartments).

Table 1.

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Margins</th>
<th>T2w signal</th>
<th>Crossing of compartments/ involvement of adjacent structures</th>
<th>Bony destruction</th>
<th>Enhancement pattern</th>
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<td>BENIGN</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Ganglion cyst</td>
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<td>NA</td>
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<td>Nil</td>
<td>Small eccentric focus of enhancement</td>
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<td>Enhancement</td>
<td>Internal Capsule Enhancement</td>
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<tr>
<td>GCTTS</td>
<td>Lobulated</td>
<td>Heterogeneous intermediate-high with low signal areas due to hemosiderin deposits</td>
<td>Nil</td>
<td>Avid, near homogeneous</td>
<td></td>
</tr>
<tr>
<td>Glomus tumour</td>
<td>Smooth</td>
<td>Homogeneously hyperintense</td>
<td>Nil</td>
<td>Avid, homogenous</td>
<td></td>
</tr>
</tbody>
</table>

**MALIGNANT**
| Undifferentiated pleomorphic sarcoma | Irregular | Heterogeneously hyperintense | Crosses compartments, areas of infiltration into adjacent muscle | Nil | Heterogeneous |
| SCC | Infiltrative | Heterogeneously hyperintense | Invading adjacent muscle, skin, bone | Yes | Heterogeneous |
| Metastasis | Infiltrative | Heterogeneously hyperintense | Invading adjacent muscle, skin, bone | Yes | Heterogeneous |
| Fibrosarcoma | Fairly well-defined | Heterogeneously intermediate to low signal | Nil | Nil | Heterogeneous, small non-enhancing foci |

The most consistent observation from this classification is that most benign lesions show homogeneous MR signal on T2-weighted images and they do not show significant internal enhancement. Exceptions are hemangiomas and schwannomas. Schwannomas may show homogenous enhancement as in our case or central enhancement when target sign is present on T2-weighted images. Hemangiomas may also show homogeneous enhancement as in our case or heterogeneous enhancement depending on distribution of fat, smooth muscle, myxoid stroma, thrombi and hemosiderin. Intermediate-grade and especially malignant lesions tend to show heterogeneous MR signal on T2-weighted images.

Benign lesions usually have smooth margins, although larger benign lesions may show lobulated margins, insinuate around adjacent structures, or cross compartments (as in cases of lipoma and fibrolipomatous hamartoma), resembling intermediate-grade lesions in this respect. However the surrounding fat planes are usually preserved, while intermediate-grade lesions may show loss of surrounding fat planes.

Bony scalloping with no overt bony destruction is suggestive of an intermediate-grade lesion (as evident in cases of GCTTS, glomus tumour, neurofibroma). Frank bony destruction, irregular, infiltrative margins certainly suggests a malignant lesion, as evident in our cases of primary squamous cell carcinoma and metastasis. An exception is that of soft tissue sarcomas. Despite their malignant nature, they may show fairly well-defined or
lobulated margins and can be confused with the intermediate-grade lesions radiologically. In these situations, heterogeneous T2 signal intensity and pattern of enhancement can be useful distinguishing feature. Another notable exception is that of nodular fasciitis. While this is a benign entity that almost never recurs after excision, the heterogeneous signal and enhancement on MR resembles that of a malignant lesion, such as a sarcoma. Moreover this lesion usually grows rapidly, adding to the diagnostic dilemma. Only excision and histological examination confirms benign nature of this lesion.

Our classification is supported by a study that suggests benign masses do tend to have homogeneous MR signal intensity and well-defined margins while malignant masses tend to have heterogeneous signal, enhancement and less well-defined margins [35]. A formal prospective study or systematic review would be required to validate our proposed classification.
References


