Imaging of extremity soft tissue masses: pitfalls in diagnosis

Soft tissue sarcomas are rare tumours which can be clinically difficult to differentiate from more common benign lesions. Imaging plays a fundamental role in diagnosis, but in some cases it can be difficult to differentiate benign from malignant conditions. This article reviews potential pitfalls in soft tissue sarcoma imaging.

Most appendicular soft tissue masses are benign. Soft tissue sarcomas are rare tumours arising from mesenchymal or connective tissue, with benign lesions outnumbering soft tissue sarcoma by 100:1. There is the potential for the unwary to misdiagnose soft tissue sarcoma as a benign lesion. Differentiating between benign and malignant lesions is important as delayed or misdiagnosis can lead to increased morbidity, mortality and potentially a lost opportunity for limb salvage surgery (O'Sullivan and Pisters, 2003).

Imaging plays a fundamental role in the diagnosis of a soft tissue mass. There are over 100 different histological subtypes of soft tissue tumour as defined by the World Health Organization (Doyle, 2014). In approximately 50% of cases the imaging appearances are non-specific and biopsy may be required for diagnosis. In a number of lesions the imaging features can cause difficulty in differentiating benign from malignant processes. These potential pitfalls are reviewed in this article with a view to increasing the reader's confidence when these lesions are encountered. The focus is specifically on the diagnosis of cystic, lipomatous and haemorrhagic masses as well as myositis ossificans.

Epidemiology

Soft tissue sarcomas are uncommon, representing approximately 1% of all malignant tumours. The incidence is approximately 1–2/100 000 of the population. In the UK in 2010 there were 3272 newly diagnosed soft tissue sarcoma of all subtypes (Cancer Research UK, 2014). The recorded incidence of soft tissue sarcoma has been rising over the past 18 years, but it is not clear if this is a true increase or the result of improved awareness, diagnosis and coding (National Cancer Intelligence Network, 2011).

Clinical features

Soft tissue sarcomas can occur anywhere but are commonest in the extremities, especially the thigh (Singer and Eberlein, 1997). Most present as a painless mass. Lesions larger than 5 cm in any location and deep-seated lesions of any size are predictors of malignancy (Rydholm, 1983). The British Sarcoma Group has tried to raise awareness, proposing that any lesion the size of a golf ball (42 mm), deep to the deep fascia, painful and increasing in size should be considered malignant until proven otherwise (Grimer, 2006; Grimer et al, 2010).

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Age and site distribution

The majority of soft tissue sarcomas occur in patients over 50 years of age. However, certain types of soft tissue sarcomas are more common in certain age groups. Certain tumours also show a predilection for certain anatomical locations. A population study with over 38 500 patients looked at the age and skeletal distribution of malignant soft tissue tumours (Kransdorf, 1995), the results of which are summarized in *Table 1*. As the imaging appearances of many soft tissue tumours can be fairly non-specific, such data are important as these can guide a differential diagnosis based on epidemiology.

Cystic masses

Cystic lesions are commonly encountered during imaging of the appendicular skeleton. Most of these lesions are benign, but certain malignant tumours can appear 'cyst-like' and knowledge of their imaging findings is vital.

Synovial cysts (*Figure 1*) are synovial lined juxta-articular fluid collections comprising a focal extension of joint fluid through the joint capsule. A ganglion is a cyst whose wall is composed of connective tissue without a synovial lining. They can be intra- or extra-articular, inter-osseous or periosteal. Radiological differentiation is not possible and the terms synovial cyst and ganglion are often used interchangeably.

Bursae are synovial lined spaces in areas of increased friction, e.g. the pre-patella bursa (*Figure 2*). A Morel-Lavallée lesion is a post-traumatic fluid collection caused by shearing of the soft tissues between the superficial and deep fascia; a cystic collection in the context of trauma suggests this (*Figure 3*).

Age (years)	Hand and wrist	Upper extremity	Foot and ankle	Lower extremity	Axilla and shoulder
0–5	Fibrosarcoma	Fibrosarcoma	Fibrosarcoma	Fibrosarcoma	Fibrosarcoma
	Angiosarcoma	Rhabdomyosarcoma	DFSP	Rhabdomyosarcoma	Rhabdomyosarcoma
	Epithelioid sarcoma	Angiomatoid PUS	MPNST or rhabdomyosarcoma	MPNST	Angiomatoid PUS
6–15	Epithelioid sarcoma	Angiomatoid PUS	Synovial sarcoma	Synovial sarcoma	Angiomatoid PUS
	Angiomatoid PUS	Synovial sarcoma	DFSP	Angiomatoid PUS	PUS
	Synovial sarcoma	Fibrosarcoma	Rhabdomyosarcoma	PUS	Ewing's sarcoma
16–25	Epithelioid sarcoma	Synovial sarcoma	Synovial sarcoma	Synovial sarcoma	Synovial sarcoma
	PUS	PUS	Clear cell	Liposarcoma	DFSP
	DFSP	MPNST	Fibrosarcoma	MPNST	MPNST
26–45	PUS	PUS	Synovial sarcoma	Liposarcoma	DFSP
	Epithelioid sarcoma	MPNST	Clear cell sarcoma	PUS	PUS
	Synovial sarcoma	Fibrosarcoma	PUS	Synovial sarcoma	Liposarcoma
46–65	PUS	PUS	PUS	PUS	PUS
	Synovial sarcoma	Liposarcoma	Synovial sarcoma	Liposarcoma	Liposarcoma
	Fibrosarcoma	Leiomyosarcoma	Leiomyosarcoma	Leiomyosarcoma	DFSP
66+	PUS	PUS	Kaposi sarcoma	PUS	PUS
	Leiomyosarcoma	Liposarcoma	PUS	Liposarcoma	Liposarcoma
	Synovial sarcoma	Leiomyosarcoma	Leiomyosarcoma	Leiomyosarcoma	MPNST

Table 1. Distribution of malignant soft tissue tumours by site and age in order of frequency

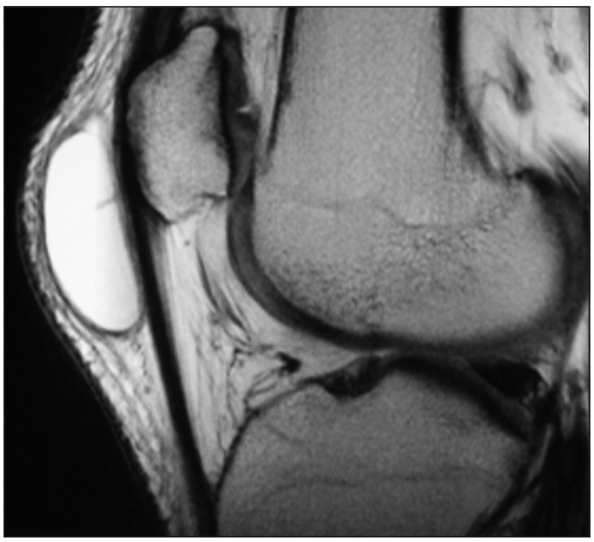
DFSP = dermatofibrosarcoma protuberans; MPNST = malignant peripheral nerve sheath tumour; PUS = pleomorphic undifferentiated sarcoma. In the original paper the term MFH (malignant fibrous histiocytoma) was used which has now been replaced by pleomorphic undifferentiated sarcoma. Modified from Kransdorf (1995)

On ultrasound imaging, simple cysts appear as anechoic thin-walled masses which may contain thin septations. Low-level internal echoes may reflect a degree of complexity such as the presence of blood or high protein content but solid elements and internal blood flow should not be present. Cysts will show posterior acoustic enhancement because of the increased transmission of ultrasound through the cyst.

On magnetic resonance imaging, cysts appear as uni/multilocular structures, which are of fluid signal intensity on all sequences. On T1 imaging they may have a fractionally higher signal than muscle because of their pro-

Figure 1. Synovial cyst. Proton density fat-saturated magnetic resonance imaging showing a synovial cyst in the hand likely to be arising from the middle finger metacarpophalangeal joint. Note the completely cystic signal characteristics in the cyst with no internal complexity or solid components.

Figure 2. Pre-patella bursae: proton density magnetic resonance imaging of the knee demonstrating a high signal lesion anterior to the patella.



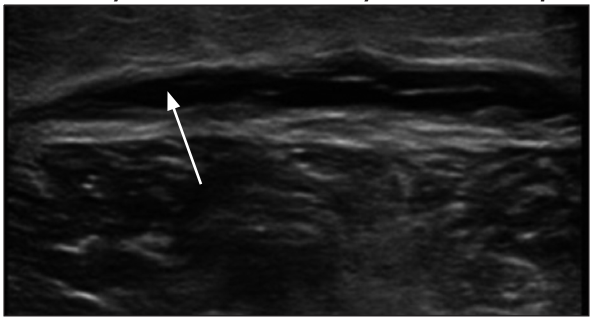
tein content. They may have thin internal septations, which may enhance following gadolinium chelate administration. However, cysts should not demonstrate areas of solid internal enhancement following administration of contrast. The presence of loose bodies, synovial proliferation, bleeding and infection can complicate the diagnosis, but they should not enhance internally, therefore if a cystic lesion has any complex features, administration of contrast material is mandatory.

There are a number of benign and malignant ‘cyst-like’ lesions on imaging that can be mistaken for simple cysts. Benign lesions include myxomas and peripheral nerve sheath tumours. Malignant lesions include synovial and myxoid sarcomas.

Benign ‘cyst-like’ lesions

Myxomas are soft tissue lesions composed of fibroblasts in myxoid stroma. They are typically remote from joints and commonly intramuscular. High mucin and water content makes them homogenously high signal on T2 weighting, so easily mistaken for a cyst. However, contrast enhancement more appropriately reflects the solid nature. Occasionally, a high signal fatty rind is seen, representing adjacent fatty muscle atrophy (Murphey et al, 2002). They are typically lower signal than muscle on T1-weighted imaging. Despite magnetic resonance imaging being the modality of choice, ultrasound can be used to confirm that the lesion is solid and not a cyst. Typical ultrasound appearances are of a well-circumscribed mass, usually in an intramuscular location (*Figure 4*). They are hypoechoic and heterogeneous, so the features are rather non-specific. The ‘bright rim’ and ‘bright cap’ signs have been described, representing fat at the periphery and at the pole of the myxoma respectively, but these findings are non-specific (Girish et al, 2006).

Figure 3. Morel-Lavallée lesion: ultrasound of the upper thigh demonstrating an anechoic lesion superficial to the deep fascia (arrow). Note a fibrous septation running through the lesion. There was a history of trauma. This is commonly seen around the hip.



Benign peripheral nerve sheath tumours (*Figure 5*) include schwannomas and neurofibromas. Schwannomas tend to be encapsulated and can be separated from the underlying nerve. Neurofibromas are non-encapsulated and cannot be separated from the underlying nerve. They are also seen in the context of neurofibromatosis, increasing the risk of malignancy (Banks, 2005). On ultrasound, lesions can have variable imaging appearances. Reynolds et al (2004) reported the ultrasound appearances of 83% of schwannomas and 50% of neurofibromas as hypo-echoic relative to skeletal muscle; 17% of schwannomas and 50% of neurofibromas had a predominantly hypo-echoic periphery and a hyperechoic centre (the ‘target’ sign) and 75% of lesions showed posterior acoustic enhancement and hence may be confused with a cyst. Schwannomas and neurofibromas have similar appearances on magnetic resonance imaging. Classic features include:

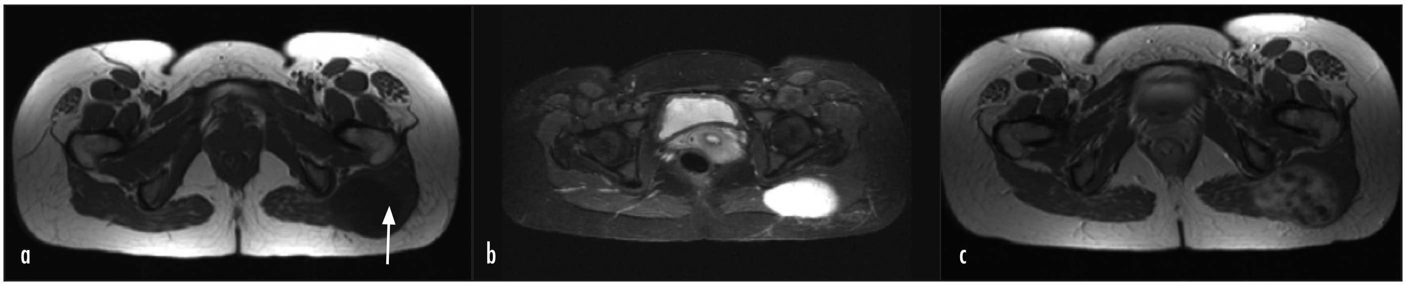
- Target sign: lower central and higher peripheral signal intensity on T2 weighting gives the impression of a target, because fibrocollaginous tissue is seen centrally and more myxomatous tissue peripherally in the lesion
- Fat split sign: the fat that surrounds the neurovascular bundle is displaced peripherally
- Tail sign: entering and exiting nerve root visualization gives the appearance of a fusiform mass with a tail at each end.

Malignant ‘cyst-like’ lesions

This group of lesions includes synovial and myxoid sarcomas. Synovial sarcomas tend to affect adolescents and young adults, usually occurring in the extremities and around joints (Murphey et al, 2006). They account for 2.5–10% of all soft tissue malignancies.

Lesions are typically heterogenous and multilobulated, with calcifications seen in up to 30% (Horowitz et al, 1973). Magnetic resonance imaging is the modality of choice. On T1 weighting, lesions are typically heterogenous and iso/hyperintense to muscle. On T2 weighting,

Figure 4. Intramuscular myxoma. a. T1-weighted image showing a hypointense lesion in the left gluteus maximus (arrow). b. Fluid sensitive sequence showing markedly hyperintense lesion – such a lesion could be misinterpreted as a cyst. c. T1 + contrast-enhanced magnetic resonance imaging shows heterogenous internal enhancement, more appropriately reflecting the solid nature of the myxoma.



lesions are heterogenous but predominantly high signal and hence can be mistaken for cysts. The heterogeneity along with calcifications/fibrous elements within the lesion gives the so-called 'triple sign' which reflects the low signal intensity (calcification/fibrous component), intermediate signal intensity (solid cellular component) and high signal intensity (haemorrhage/necrosis) in such lesions.

Septations can be seen in 67–75% of cases (Tateishi et al, 2004). Fluid levels can be seen in up to 25% which, along with septations and cystic areas, gives the so-called 'bowl of grapes' sign (Murphey et al, 2006). Following contrast administration, there is prominent enhancement, which is usually heterogeneous, reflecting the lesion's mixed composition. A predominantly cystic lesion could therefore be mistaken for a simple cyst if no contrast is administered. In children, rarely a painless slow-growing cystic appearing synovial sarcoma may be encountered (*Figure 6*). This is a classic pitfall in soft tissue sarcoma diagnosis. If such a lesion is suspected, imaging with contrast is mandatory.

Figure 5. Benign peripheral nerve sheath tumour. a. Proton density fat-saturated lesion showing hyperintense signal intensity. Note the appearance of a 'tail' at the superior margin of the lesion corresponding to the entering nerve root (arrow). b. Target sign. The higher peripheral and lower central signal intensity gives the appearance of a 'target'. c. Fat split sign. T1 weighted image of a benign peripheral nerve sheath tumour. Note the lesion displaces the surrounding perilesional fat – the 'fat split' sign.

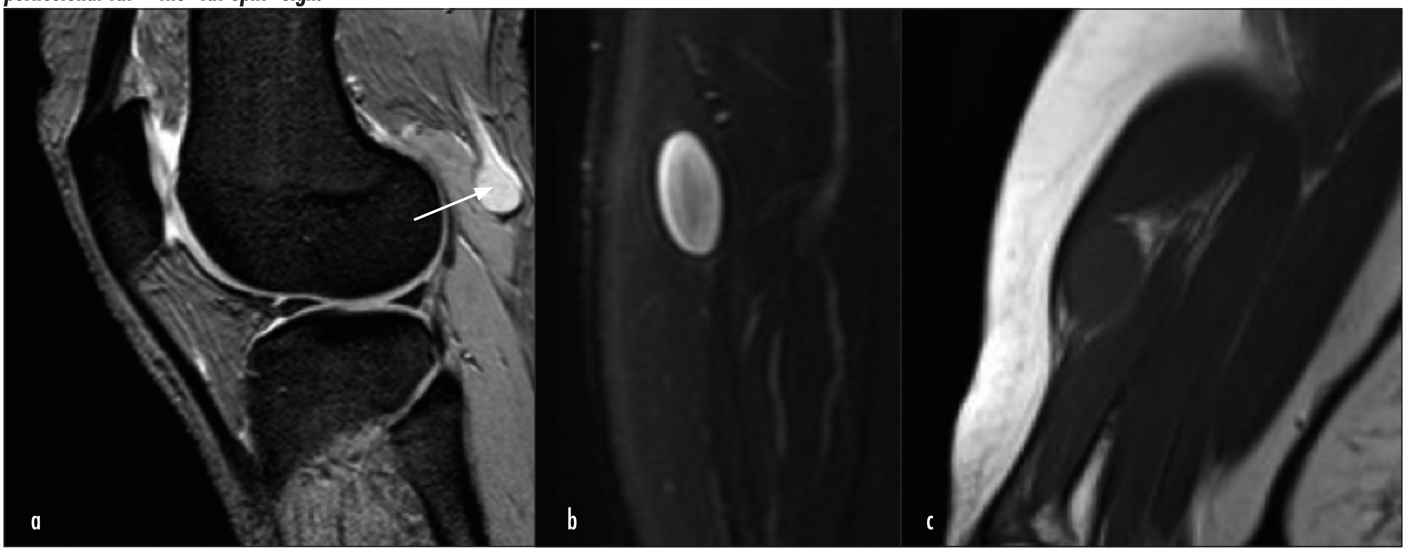
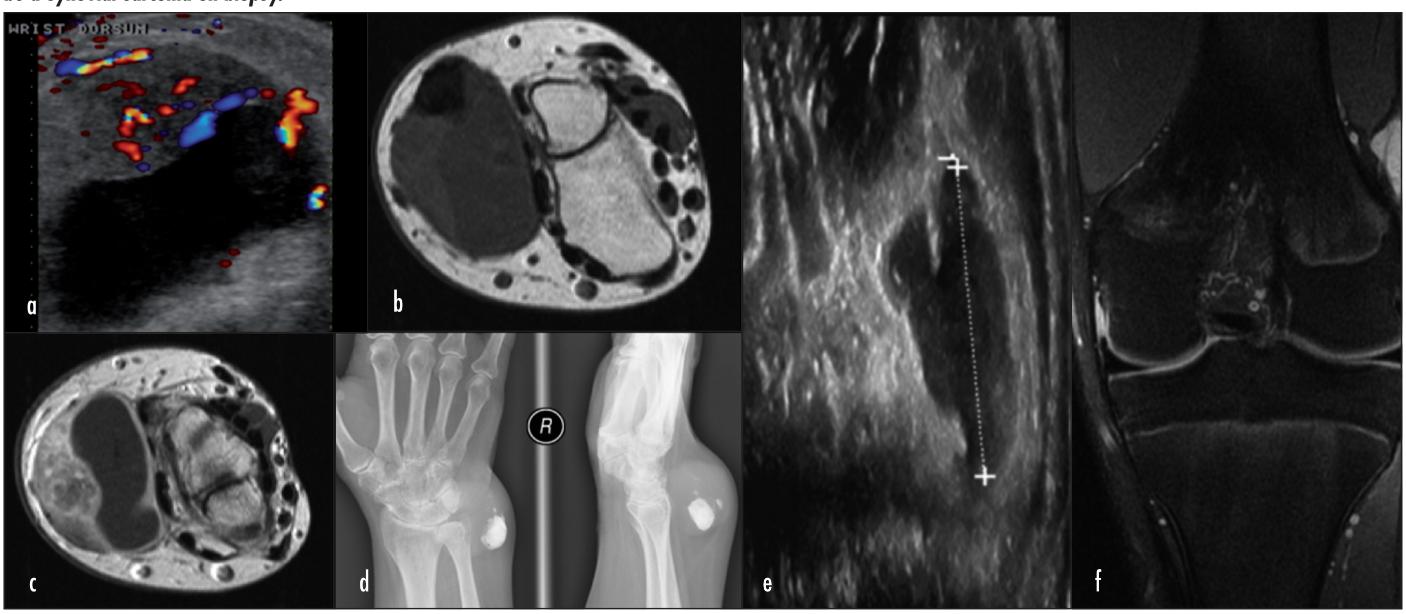


Figure 6. Synovial sarcoma. a. Ultrasound of the upper extremity demonstrating a predominantly hypoechoic lesion with an irregular wall. A solid hypervascular component is present. b. T1-weighted magnetic resonance imaging demonstrating the hyperintense signal of the solid component and the hypointense cystic component of the synovial sarcoma. c. T1 post contrast magnetic resonance imaging demonstrates enhancement of the solid component of the lesion. d. Radiograph of the same patient showing extensive calcification within the lesion. e. Ultrasound and (f) magnetic resonance imaging of the lower extremity showing a cystic-appearing lesion in the lower extremity. Note the irregular wall and low level echoes on the ultrasound suggesting the lesion is not a simple cyst. This turned out to be a synovial sarcoma on biopsy.



Myxoid sarcomas include myxofibrosarcoma and myxoliposarcoma. Myxofibrosarcoma is a relatively common lesion seen in the elderly and is composed of myxoid stroma, spindle cells and small blood vessels. It has low/intermediate signal intensity on T1-weighted imaging (*Figure 7*), the myxoid component giving high signal intensity on T2 weighting, similar to that of fluid. Septations are of low signal intensity.

High-grade lesions have less T2 signal intensity, and the lack of fat distinguishes them from myxoliposarcomas (van Vilet et al, 2009).

Myxoliposarcomas are malignant myxomatous masses containing varying degrees of fat. The myxomatous component of the lesion gives the impression of a cystic lesion on magnetic resonance imaging. Following contrast administration, lesions show a varying pattern of enhancement. In cases with minimal enhancement, ultrasound may indicate whether the lesion is or is not truly cystic.

Lipomatous lesions

Lipomatous soft tissue lesions are the largest group of mesenchymal tumours (Doyle, 2014). Their magnetic resonance imaging appearances are usually characteristic enough to allow a specific diagnosis, but in some cases differentiating between a lipoma and an atypical lipomatous tumour remains challenging.

Lipomas are benign fatty tumours in which the fat resembles normal subcutaneous fat. Atypical lipomatous tumours are often larger, contain bands of collagen, gelatinous areas and have cells with a greater variation in size and shape. The term well-differentiated liposarcoma is used synonymously with atypical lipomatous tumour, but atypical lipomatous tumour is preferred for lesions in the extremities. Lipomas and atypical lipomatous tumours can occasionally show overlap on imaging appearances.

Ultrasound is usually the first line of investigation. Classically, superficial lipomas tend to be well-defined, ovoid, hyperechoic masses with homogenous echogenicity. Thin septations (<2 mm) may be seen. Deeper lipomas have more variable imaging appearances and hence further cross-sectional imaging is needed, especially in the presence of features that suggest malignancy including patient age >60 years, lesions deep to the deep fascia

Figure 7. Myxoid sarcoma. a. Myxoid liposarcoma: STIR (short tau inversion recovery) image demonstrating the fatty component of the lesion (low signal - arrow) and high signal in the lesion, which represents the myxoid stroma component. b. Myxoid fibrosarcoma: T1-weighted image demonstrating a hyperintense lesion with no discernible fat within it. This differentiates it from a myxoid liposarcoma. c. Myxoid fibrosarcoma: STIR image demonstrating the myxoid component.

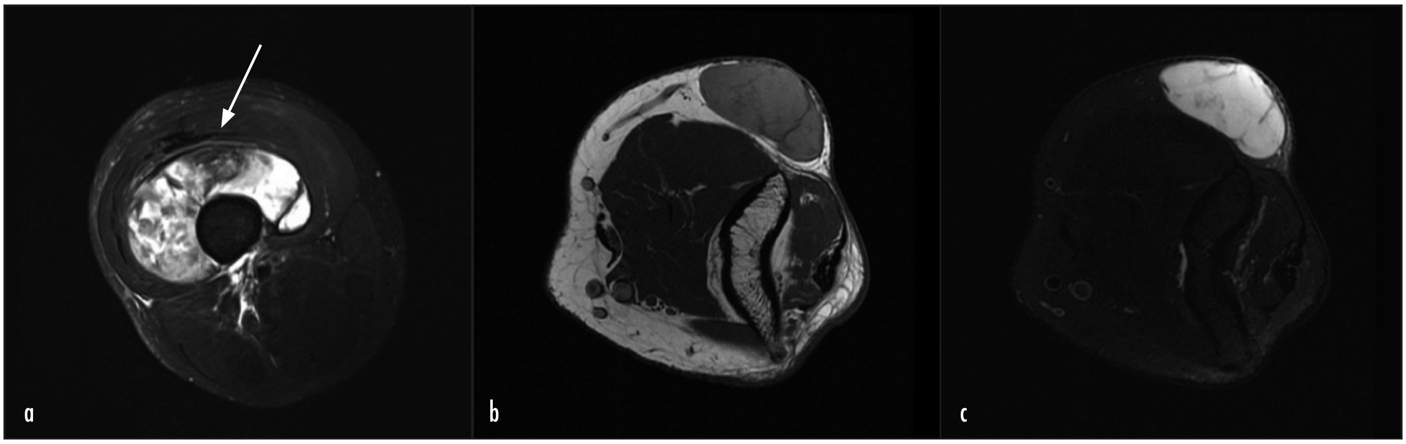
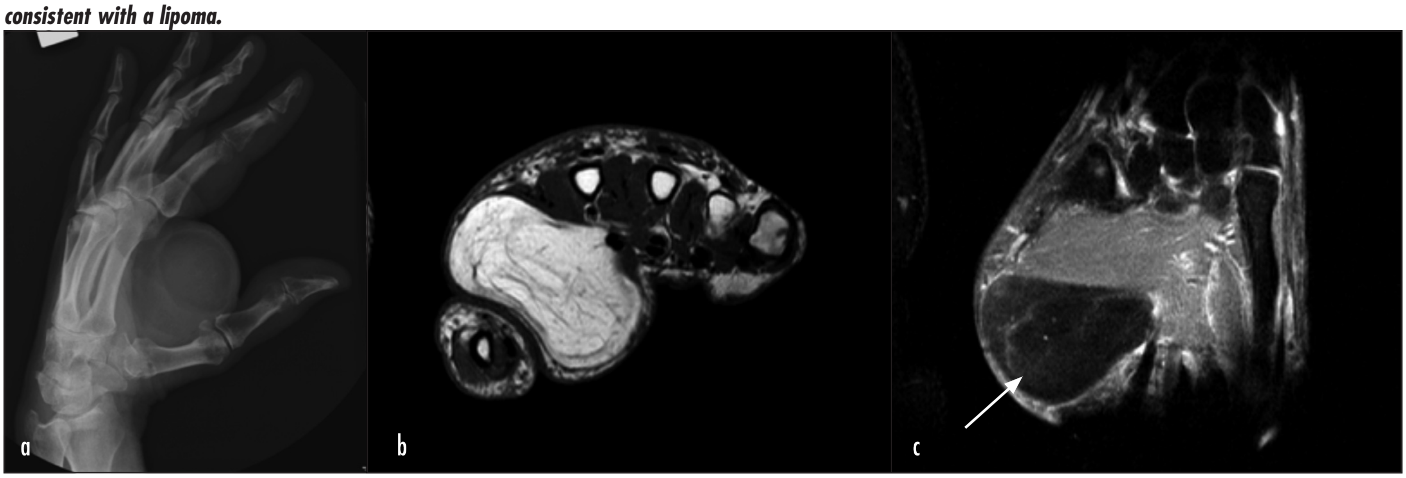


Figure 8. Lipoma. a. Hand X-ray showing low attenuation mass in the thenar eminence. Faint areas of calcification are seen. b. T1 image demonstrating a lesion with the same signal intensity as subcutaneous fat. c. Complete suppression of the lesion on the fat saturation sequence (arrow), therefore the lesion would be consistent with a lipoma.



and thick or nodular septae. Ultrasound cannot reliably differentiate between atypical lipomatous tumour and lipoma because of the wide variation and overlap in the imaging appearances and magnetic resonance imaging is the modality of choice.

Lipomas typically resemble subcutaneous fat on computed tomography and magnetic resonance imaging. Calcification can be present and is seen in up to 11% of cases (Kransdorf et al, 2002). Lipomas can contain other mesenchymal elements – usually fibrous connective tissue appearing as traversing strands or septae of varying thickness on magnetic resonance imaging. When the fibrous component is large or irregular it may give a more nodular appearance, complicating the diagnosis. Differentiation between lipoma and atypical lipomatous tumour (*Figure 9*) is relatively straightforward when the lipoma displays homogenous fatty signal similar to subcutaneous fat without internal complexity, but when non-lipoid elements are present this distinction is more difficult.

Studies comparing the magnetic resonance imaging characteristics of lipomas and atypical lipomatous tumours have shown that lesions >10 cm, deep location, thick septae, nodularity and the presence of non-fatty areas are more likely to be atypical lipomatous tumours (Kransdorf et al, 2002).

Another study showed that lesions with no discernable non-adipose elements were all benign lipomas, and the presence of thick septae and non-adipose elements favoured atypical lipomatous tumour. Intense septal enhancement favoured a diagnosis of atypical lipomatous tumour (Oghuri et al, 2003).

Altered fat signal within a lesion on fluid-sensitive magnetic resonance imaging sequences has been proposed as a method to differentiate lipomas from atypical lipomatous tumour. However, Brisson et al (2013) found that in 14 cases where the radiological diagnosis was based on this feature alone, nine turned out to be lipomas. Therefore this feature in isolation may result in a number of false positive results.

The appearance of an atypical lipomatous tumour reflects the differentiation seen within it – the more well differentiated the lesion the more it will look like subcutaneous fat and vice versa. Typically an atypical lipomatous tumour will be a predominantly fatty mass with non-fatty elements including nodular septations, which are low signal intensity on all sequences. The septae can have a variable appearance but thickness (greater than 2 mm) and nodularity is a significant predictor of malignancy (Kransdorf et al, 2002).

Haemorrhagic lesions

Soft tissue sarcoma with intralesional haemorrhage is well described, occurring with or without trauma. In the presence of trauma the diagnosis can be challenging because a soft tissue mass following trauma could, very reasonably, be attributed to haematoma rather than malignancy. In patients on anticoagulation or antiplatelet drugs, extra caution should be taken so that a soft tissue sarcoma with intra-lesional haemorrhage is not missed.

The appearance of haemorrhage on magnetic resonance imaging depends on the age of the haematoma. As a haematoma ages, the haemoglobin passes through several forms. Five distinct stages of haematoma can be identified (*Table 2*).

A haematoma is absorbed over time so if a mass regresses spontaneously it favours this as a diagnosis over a haemorrhagic soft tissue sarcoma. Occasionally a fibrous wall can develop giving rise to a chronic expanding haematoma, which can be hard to differentiate from a haemorrhagic soft tissue sarcoma. Ultrasound appearances vary depending on the age of the haematoma. Initially lesions have a more solid appearance before undergoing liquefaction. The fluid portion may have septae within it and contain low level echoes, and fluid levels may also be seen. On magnetic resonance imaging, the haematoma wall has low signal intensity on both T1 and T2 sequences (*Figure 10*). Contrast enhancement is seen in the fibrous capsule rather than centrally.

Intra-lesional haemorrhage within a sarcoma can be spontaneous or the result of trauma. The sarcomas most commonly associated with haemorrhage are pleomorphic undifferentiated sarcoma, synovial sarcoma, extraskeletal Ewing's, liposarcoma and angiosarcoma (Kontogeorgakos et al, 2010).

Figure 9. Atypical lipomatous tumour. a. T1-weighted image of the pelvis showing large pelvic fatty mass on the right (arrows). b. Fat saturation images of the same patient showing thickened septations which do not saturate out like the rest of the lesion (arrow). Note the size of the lesion >10 cm.

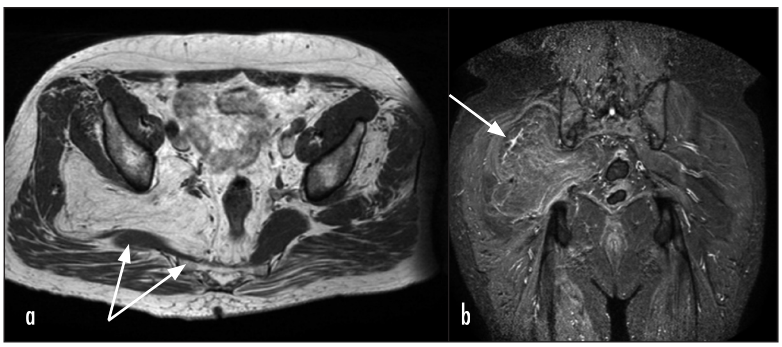


Table 2. Five stages of haemorrhage as identified on magnetic resonance imaging

Age	Compartment	Haemoglobin	T1	T2
<24 hours	Intracellular	Oxyhaemoglobin	Isointense	Hyperintense
1–3 days	Intracellular	Deoxyhaemoglobin	Iso to hyperintense	Hypointense
>3 days	Intracellular	Methaemoglobin	Hyperintense	Hypointense
>7 days	Extracellular	Methaemoglobin	Hyperintense	Hyperintense
>14 days	Extracellular	Haemosiderin	Hypointense	Hypointense

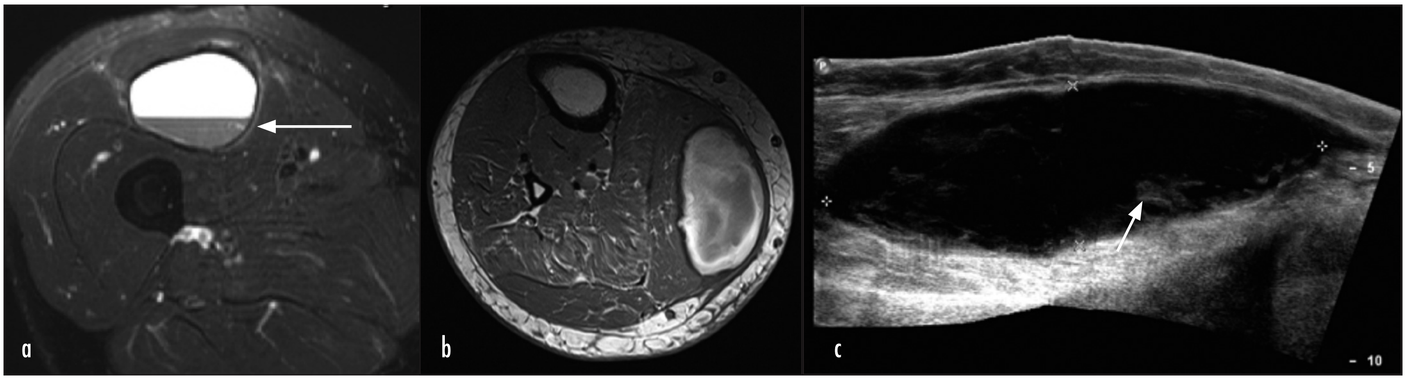


Figure 10. Haematoma. a. Fat saturation image showing an intramuscular haematoma with thin wall and layering of the blood degradation products giving a fluid–fluid level (arrow). b. T1-weighted image demonstrating peripheral low signal in keeping with haemosiderin deposition and a mixed signal centre. The hyperintense periphery is suggestive of recent haemorrhage and the low signal intensity central clot. This did not enhance following contrast thereby differentiating from a haemorrhagic soft tissue sarcoma. c. Ultrasound of the calf following trauma. Note predominantly anechoic collection in calf with slightly more solid areas, which are echogenic in nature (arrow). No internal colour flow was demonstrated.

Haemorrhagic soft tissue sarcoma can present with a mass, pain and occasionally a surrounding ecchymosis. However, these lesions will not resorb and will persist or enlarge. The ultrasound features of such lesions depend on the timing of the bleeding and can be of a mass lesion with heterogeneous cystic areas representing intra-lesional haemorrhage and solid areas representing tumour. Internal echoes within the cystic component favour recent haemorrhage.

The magnetic resonance imaging appearance of a haemorrhagic soft tissue sarcoma depends on the chronicity of the bleeding (*Figure 11*). The haemorrhagic component can have a variety of signal intensities (*Table 2*), this is non-enhancing following contrast administration. The sarcomatous parts of the lesion will be of low/intermediate signal intensity on T1 with enhancement of the solid component of disease. The wall of the haemorrhagic component may enhance following contrast administration, but the wall of a haemorrhagic sarcoma is usually thicker and more irregular than a chronic haematoma (Imaizumi et al, 2002).

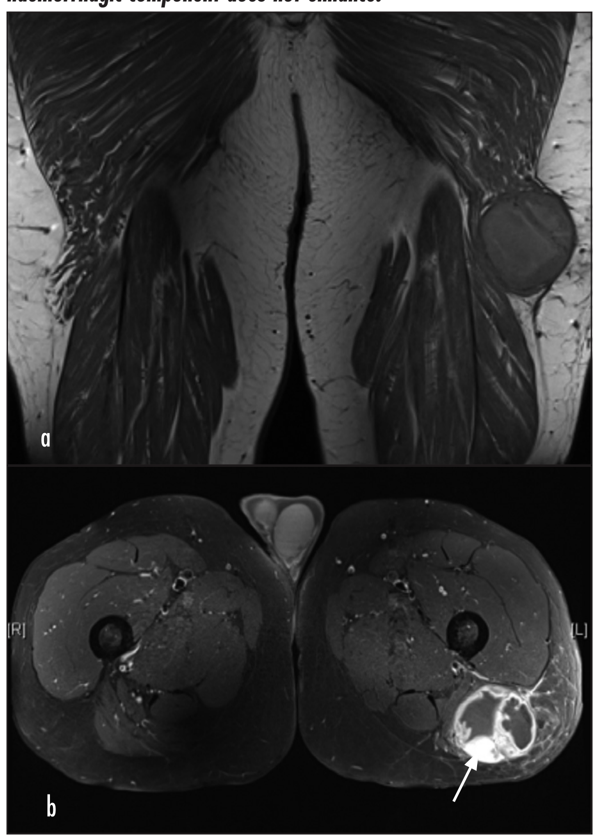
Myositis ossificans

Myositis ossificans is a pseudo-inflammatory tumour seen in soft tissues that can be mistaken for a malignant lesion. It is a reparative form of heterotopic ossification typically seen in skeletal muscle, usually following trauma. Most cases occur between 15 and 40 years of age. Common sites are the upper arm and thigh.

The diagnosis, especially in the absence of injury, can be difficult and imaging features can vary depending on the age, location and degree of ossification in the lesion. Because of the variety of imaging appearances, these lesions can be confused with soft tissue sarcoma, especially ones which calcify such as synovial sarcoma or extra-skeletal or parosteal osteosarcoma.

The natural history of myositis ossificans can help explain the various imaging appearances. There are three phases: early (up to 14 days), intermediate (14 days to 6 months) and late (>6 months). Early phase lesions contain central fibroblasts. Lesions then go on to display peripheral osteoid deposition as fibroblasts are replaced by osteoblasts secreting osteoid material peripherally. Older, late phase lesions will display an outer region of

Figure 11. Haemorrhagic soft tissue sarcoma. a. T1 coronal image of a lesion in the thigh. The central area is hyperintense relative to skeletal muscle consistent with haemorrhage. There is a markedly thickened irregular wall with a thick central septation. b. T1 post contrast fat saturation image showing enhancement of the irregular thickened nodular wall (arrow) and central septation. The haemorrhagic component does not enhance.



woven lamellar bone, and some lesions fuse with the periosteum of underlying bone, which can be confused for parosteal osteosarcoma. The central area can remain undifferentiated, often transforming into a collagenous area which can ossify (Myers, 2008).

On radiographs, early phase lesions can show a soft tissue mass with peripheral calcification and there may be an associated underlying adjacent periosteal reaction. Subsequently the calcification becomes denser and coarser, progressing to a peripheral cortex in late phase lesions. The presence of internal calcifications can also be seen parallel to the long axis of the bone and muscle (Tyler and Saifuddin, 2010) (*Figures 12* and *13*).

On magnetic resonance imaging, early phase lesions are poorly defined areas of low/intermediate or slightly high signal intensity on T1 weighting with generally high signal intensity on T2 weighting. Florid compartment oedema can be seen, such oedema is not seen in soft tissue sarcoma. Small calcific foci are seen as low signal intensity areas on T1 weighting. Gadolinium enhancement is typically seen.

Intermediate phase lesions have a variable appearance on magnetic resonance imaging. On T1 weighting the central area is iso/hyperintense relative to muscle. On fluid sensitive sequences the central portion is usually high signal interspersed with areas of lower signal intensity peripherally reflecting the degree of ossification. Perilesional oedema is also decreased.

Mature lesions are usually low signal on all magnetic resonance sequences, reflecting the amount of ossification and fibrosis. Perilesional oedema is now not usually evident (Myers, 2008; Tyler and Saifuddin, 2010) (*Figure 14*).

Computed tomography is extremely useful in making the diagnosis. In the acute phase it defines a soft tissue mass with or without areas of calcification. High attenuation areas within a lesion may indicate haemorrhage. As lesions mature, a peripheral rim of calcification develops, becoming thicker as the lesion develops. No invasion should be seen with myositis ossificans. Lesions close to bone may show an initial periosteal reaction and medullary changes, subsequent progression of such a lesion with these features can be monitored by serial computed tomography. This will ensure that an underlying malignant lesion is not being missed, that the lesion is maturing typically (peripheral ossification) and the bony changes are regressing or static. Malignant lesions such as soft tissue variant of osteosarcoma or parosteal osteosarcoma should show central rather than peripheral ossification.

Diagnosis in the acute phase can be more problematic given the lack of peripheral calcification and differentials include soft tissue abscess, soft tissue sarcoma and haematoma. At this stage biopsy should be avoided and may be misinterpreted.

Conclusions

Distinguishing a benign lesion from a soft tissue sarcoma on the basis of imaging findings can sometimes be challenging. It is important to recognize the clinical presentation that soft tissue sarcoma may show considering features such as size, location and age distribution.

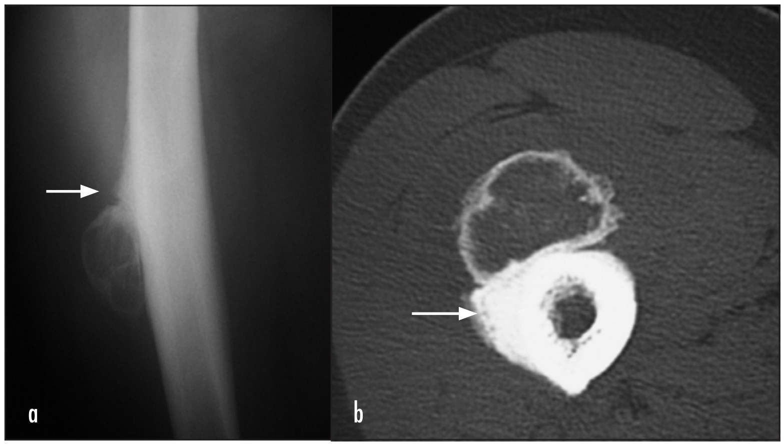


Figure 12. Myositis ossificans or periostitis ossificans – periosteal reaction. a. Radiograph demonstrating a mass with peripheral calcification. Note the presence of a periosteal reaction seen superior to the lesion (arrow). b. Computed tomography demonstrating lesion with peripheral calcification and periosteal reaction (arrow).

Figure 13. Myositis ossificans on magnetic resonance imaging. Fluid-sensitive sequence demonstrating a mass with considerable perilesional oedema – such an 'inflammatory' appearance would be consistent with an early phase lesion.

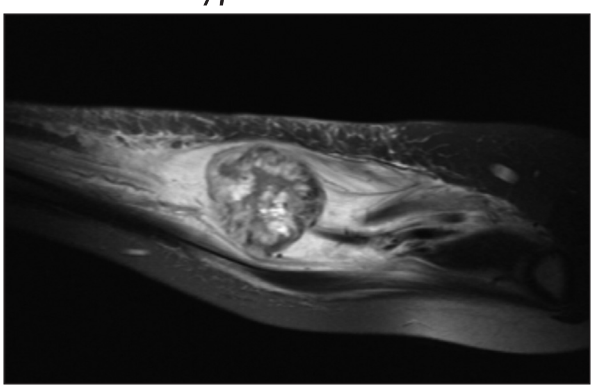
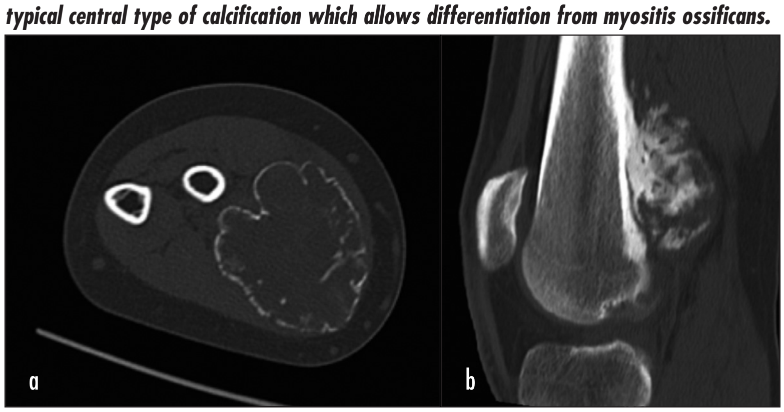


Figure 14. a. The typical computed tomography appearance of myositis ossificans. An intramuscular lesion with peripheral calcification. b. Parosteal osteosarcoma with the typical central type of calcification which allows differentiation from myositis ossificans.



The role of imaging continues to expand but it is important for clinicians who infrequently encounter such lesions to be aware of some pitfalls in diagnosis. Where imaging fails to provide a definitive diagnosis referral to a specialist centre should be considered so that further investigations, often in the form of a biopsy, can be undertaken. **BJHM**

Conflict of interest: none.

Banks KP (2005) The target sign: extremity. *Radiology* **234**(3): 899–900

Brisson M, Kashima T, Delaney D et al (2013) MRI characteristics of lipoma and atypical lipomatous tumor/well-differentiated liposarcoma: retrospective comparison with histology and MDM2 gene amplification. *Skeletal Radiol* **42**: 636–47 (doi: 10.1007/s00256-012-1517-z)

Cancer Research UK (2014) Soft Tissue Sarcoma. www.publication.cancerresearchuk.org/downloads/Products/CS_KF_STS.pdf (accessed 14 March 2015)

Doyle LA (2014) Sarcoma Classification: An update based on the World Health Organization Classification of Tumours of Soft Tissue and Bone. *Cancer* **120**: 1763–74 (doi: 10.1002/cncr.28657)

Girish G, Jamdar DA, Landry D, Finlay K, Jacobson JA, Friedman L (2006) Sonography of intramuscular Myxomas. The bright rim and bright cap signs. *J Ultrasound Med* **25**: 865–9

Grimer RJ (2006) Size matters for sarcomas. *Ann R Coll Surg Engl* **88**(6): 519–24

Grimer R, Judson J, Peake D, Seddon B (2010) Guidelines for the management of soft tissue sarcomas. *Sarcoma* (doi: 10.1155/2010/506182)

Horowitz AL, Resnick D, Watson RC (1973) The roentogen features of synovial sarcoma. *Clin Radiol* **24**: 481–4

Imaizumi S, Morita T, Ogose A, Hotta T, Kobayashi H, Ito T, Hirata Y (2002) Soft tissue sarcoma mimicking chronic haematoma. *J Orthop Sci* **7**: 33–7

Kontogeorgakos VA, Martinez S, Dodd L, Brigman BE (2010) Extremity soft tissue sarcoma presented as haematomas. *Arch Orthop Trauma Surg* **130**: 1209–14 (doi: 10.1007/s00402-009-0987-5)

Kransdorf MJ (1995) Malignant soft tissue tumors in a large referral population: Distribution of diagnosis by age, sex and location. *Am J Roentgenol* **164**: 129–34

Kransdorf MJ, Bancroft LW, Peterson JJ, Murphey MD, Foster WC, Temple HT (2002) Well differentiated fatty tumors: distinction of lipoma from well differentiated liposarcoma. *Radiology* **224**: 99–104

Murphey MD, McRae GA, Fanburg-Smith JC, Temple HT, Levine AM, Abouulafia AJ (2002) Imaging of soft tissue myxoma with emphasis on CT and MRI and comparison of radiologic and pathological findings. *Radiology* **225**(1): 215–24

Murphey MD, Gibson MS, Jennings BT, Crespo-Rodriguez AM, Fanburg-Smith JC, Gajawski DA (2006) Imaging of synovial sarcoma with radiologic-pathologic correlation. *Radiographics* **26**: 1543–65

Myers S (2008) *MRI of bone and soft tissue tumors and tumor like diagnosis. Differential diagnosis and atlas.* Thieme, Stuttgart, New York

National Cancer Intelligence Network (2011) Soft Tissue Sarcomas: incidence and survival rates in England. www.ncin.org.uk/publications/data_briefings/soft_tissue_sarcoma (accessed 14 March 2015)

Oghuri T, Aoki T, Hisaoka M et al (2003) Differential diagnosis of benign peripheral lipoma from well-differentiate liposarcoma on MR imaging: is comparison of internal characteristics useful? *AJR Am J Roentgenol* **180**(6): 1689–94

O'Sullivan B, Pisters PW (2003) Staging and prognostic factors evaluation in soft tissue sarcoma. *Surg Oncol Clin N Am* **12**: 333–53

Reynolds DL, Jacobson JA, Inampudi P, Jamadar, DA, Ebrahim FS, Hayes CW (2004) Sonongraphic characteristics of peripheral nerve sheath tumours. *Am J Roentgenol* **182**(3): 741–4

Rydholm A (1983) Management of patients with soft tissue sarcoma. Strategy developed at regional oncology center. *Acta Orthop Scand* **203**: 13–77

Singer S, Eberlein TJ (1997) Surgical management of soft tissue sarcoma. In: Cameron JL, Balch CM, Langer B et al, eds. *Advances in Surgery.* Vol 31. Mosby-Year Book, Inc, St. Louis: 395–420

Tateishi U, Hasegawa T, Beppu Y, Satake M, Moriyama N (2004) Synovial sarcoma of the soft tissues: prognostic features of imaging features. *J Comput Assit Tomogr* **28**: 140–8

Tyler P, Saifuddin A (2010) The imaging of myositis ossificans. *Semin Musculoskelet Radiol* **14**: 201–16 (doi: 10.1055/s-0030-1253161)

van Vilet, Kliffen M, Krestin GP, van Diikje CF (2009) Soft tissue sarcomas at a glance: clinical, histological and MR imaging featuresof malignant extremity soft tissue tumors. *Eur Radiol* **19**(6): 1499–511 (doi: 10.1007/s00330-008-1292-3)

KEY POINTS

- If a cystic-appearing lesion is not homogenously low signal intensity on T1 and high signal intensity on T2-weighted imaging and contains internal complexity, administration of intravenous contrast is advised to rule out a lesion with solid components such as a synovial sarcoma.
- Differentiation of lipoma and atypical lipomatous tumour can be difficult. Predictors of malignancy include size >10 cm, deep location and the presence of non-fatty elements.
- The presence of a soft tissue mass following minimal trauma should raise the suspicion of a soft tissue sarcoma possibly with intra-tumoural haemorrhage rather than a haematoma or soft tissue injury.
- Consider a haemorrhagic soft tissue sarcoma if a haematoma does not resolve following initial conservative management.
- If a haemorrhagic soft tissue sarcoma is suspected have a low threshold for contrast-enhanced imaging and biopsy of the enhancing areas.
- The appearance of myositis ossificans depends on the stage of the disease.
- If presented with an inflammatory looking mass in the context of trauma consider myositis ossificans. Consider serial computed tomography to identify a peripheral pattern of calcification.
- The calcification pattern in sarcoma is central, rather than peripheral as in myositis ossificans.