Soft tissue lipomas, lipoma variants and liposarcomas: MRI evaluation and review of literature

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Learning Objectives

We aim to introduce the radiological spectrum of lipomatous lesions, ranging from benign simple lipomas to atypical lipomas to frankly malignant liposarcomas.

The characteristic magnetic resonance (MR) features of various lipomatous lesions that aid in the differentiation of benign from malignant lesions will be highlighted. The subtypes of liposarcomas, based on the World Health Organization (WHO) classification, will be discussed.
Background

The spectrum of fat-based lesions is frequently encountered in everyday practice. Benign lipomas are the most frequently encountered soft tissue tumors whereas liposarcomas are the second most common soft tissue malignancy in adults.

The MR diagnosis of a simple lipoma is usually straightforward, with specificity approaching 100% in several studies. However, the diagnosis of atypical lipomatous lesions and liposarcomas remains a potential pitfall. The differentiation of benign from malignant tumors is crucial as it influences management and prognosis. The radiologist should keep a high vigilance for certain imaging features that would raise the suspicion for malignancy.
Imaging Findings OR Procedure Details

Due to its superior soft-tissue differentiation, MR imaging is frequently used in the work-up of lipomatous lesions. Whilst typical benign lipomas display characteristics imaging features to make a definite diagnosis, atypical lipomas and liposarcomas require the identification of "red-flags" that herald the need for further follow-up and histological diagnosis. Particularly, the differentiation of well-differentiated liposarcoma from benign lipoma is frequently recognised as a diagnostic dilemma.

**Lipoma**

Lipoma is a benign mesenchymal tumor whereby the lesion closely resembles normal fat. Simple lipomas are generally homogeneously fatty contents, and may contain a few thin, discrete septa Fig. 1 on page 9. Bands of muscle fibers may be seen in intramuscular lipomas.

**Differentiating Lipomas from Well-Differentiated Liposarcomas**

Well-differentiated liposarcomas may resemble lipomas radiologically, and it has been acknowledged that well-differentiated liposarcoma may be wrongly diagnosed as lipoma, and vice versa.

Macroscopically, well-differentiated liposarcomas tend to be larger, are often traversed by dense bands of collagen and have gelatinous areas compared to a simple lipoma. Histologically, well-differentiated liposarcomas may compose of either entirely or in part of mature adipocytic proliferation showing significant variation in adipocyte cell size, as well as presence of atypical hyperchromatic cells with angular nuclei, and lipoblasts.

Imaging features favoring a diagnosis of liposarcoma include lesion size of more than 10 cm, presence of thickened septa (>2mm), globular and/or nodular non-adipose components, fatty component less than 75% and prominent areas of enhancement Fig. 2 on page 9 and Fig. 3 on page 10.

Both lipoma and liposarcoma demonstrated thin septa and regions of increased signal intensity on fluid-sensitive MR images.
Additionally, the subjacent subcutaneous fat acts as control for the fatty contents within a lipomatous tumor. A deviation in appearance from normal fat raises a concern about the benign nature of a lipomatous tumor.

**Subtypes of Soft-Tissue Liposarcoma**

Liposarcoma is the second most common type of soft-tissue sarcoma, accounting for 10%-35% of such lesions. The World Health Organization (WHO) has categorized soft-tissue liposarcomas into six distinct histologic subtypes, namely the well-differentiated, dedifferentiated, myxoid, round cell, pleomorphic and mixed type.

Atypical lipomatous lesion and well-differentiated liposarcoma represent the lowest-grade lesions in the spectrum of liposarcomas. Higher grades of liposarcomas generally do not confound to MR findings of grossly fatty lesions as they typically do not contain or contain little macroscopic fat.

**Well-Differentiated Liposarcoma / Atypical Lipomatous Lesion**

Well-differentiated liposarcoma represents the most common subtype, accounting for approximately 50% of all liposarcomas. In the WHO Classification of Tumours of Soft Tissue and Bone (2002) and Rosai and Ackerman's Surgical Pathology (2004), atypical lipomatous tumours are synonymous with well-differentiated liposarcomas. The diagnosis of "atypical lipomatous tumour" is used in the absence of dedifferentiation for lesions arising at surgically amenable locations in the limbs and on the trunk since, at these sites, wide excision should usually be curative and hence the diagnosis 'sarcoma' is not warranted. However, in sites such as the retroperitoneum and mediastinum, it is commonly impossible to obtain a wide surgical excision margin. In such cases, local recurrence is almost inevitable and this often leads to mortality, even in the absence of dedifferentiation and metastasis - hence, at these sites, retention of the term well-differentiated liposarcoma is justified. Both lesions are otherwise identical morphologically, karyotypically and in biological potential.

Well-differentiated liposarcomas frequently demonstrate diagnostic MR appearances, with a largely lipomatous mass (>75% of the lesion) and non-lipomatous components in the form of thick septa or focal nodules.

Finding of a nodular dominant focus (>1 cm in size) of non-adipose tissue in a well-differentiated liposarcoma suggests dedifferentiated liposarcoma Fig. 4 on page 11 . In such cases, biopsy should be considered and directed at the non-adipose component.
The deep soft tissues of the lower extremities are most commonly involved (65%-75% of cases), particularly in the thigh. The retroperitoneum is the second most common location (20%-33% of cases), followed by the upper extremity (14%).

**Dedifferentiated Liposarcoma**

Dedifferentiated liposarcoma represents a biphasic neoplasm, with one component being a well-differentiated liposarcoma and the other a non-lipogenic sarcoma of variable histological grade.

Overall, dedifferentiation occurs in approximately 10% of well-differentiated liposarcomas. The risk of dedifferentiation is higher with deep seated lesions (particularly retroperitoneal) and is significantly less in the limbs.

Clinically, the history of a rapid increase in size of a pre-existing well-differentiated liposarcoma may herald dedifferentiation. Lesions in the retroperitoneum are often discovered incidentally.

**Myxoid Liposarcoma**

Myxoid liposarcoma is the second most common subtype, accounting for more than one-third of the liposarcomas. Included in this category are lesions previously categorized as round cell liposarcomas. Myxoid liposarcomas are generally considered intermediate grade lesions if they are predominantly myxoid in content, but are deemed high-grade if they contain a substantial amount of round cell component.

The high water content of myxoid liposarcoma seen at pathologic analysis corresponds to the MR findings of a large, well-defined, multilobulated high-water content mass with predominant low signal intensity with T1-weighting and high signal intensity with T2-weighting Fig. 5 on page 12. An adipocytic component is characteristically present, albeit constituting only a small proportion of the lesion. Fat is often seen in the septa or as small nodular foci within the lesion.

These lesions predominantly affect the lower extremity (75%-80% of cases), particularly the medial thigh and popliteal regions. Other locations in the lower extremities include the groin, buttock, and calf. The retroperitoneum constitutes about 8% of the lesions, followed by the upper extremity which accounts for 5%.

Myxoid and round cell liposarcoma, even if still classified by the World Health Organization as two distinct subtypes, share both clinical and morphologic features.
Lesions combining both patterns are very frequent Fig. 6 on page 13 and wide agreement exists in considering round cell liposarcoma as the high-grade counterpart of myxoid liposarcoma.

**Pleomorphic Liposarcoma**

Pleomorphic liposarcomas are the least common among the subtypes. They are high-grade sarcomatous lesions that typically appear as heterogeneous soft-tissue masses. Small amounts of fat can be seen in up to 75% of cases, which may suggest the diagnosis in MR studies Fig. 7 on page 14.

Pleomorphic liposarcoma tends to occur on the extremities, most frequently in the lower followed by the upper limbs. The trunk and the retroperitoneum are less commonly affected. Rare sites of involvement include the mediastinum, paratesticular region, scalp, abdominal or pelvic cavities, as well as the orbit.

These lesions are aggressive in nature with 30-50% incidence of metastases, particularly to the lungs. There is an overall tumour-associated mortality of 40% to 50%.

The MR appearance of pleomorphic liposarcoma is non-specific, and typically reveals a relatively well-defined mass, although infiltrative margins may be seen. Areas of necrosis and hemorrhage are frequent and account for the prominent intralesional heterogeneity seen at imaging.

Compared with other types of liposarcoma, pleomorphic liposarcoma tends to contain less adipose tissue, which reflects the higher degree of anaplasia and hence higher grade of these lesions. Such feature may confound the initial imaging suspicion of an adipocytic tumor.

**Mixed-type Liposarcoma**

Mixed-type liposarcomas have features representing a combination of the other subtypes Fig. 8 on page 15. Common sites of involvement are the retroperitoneum and abdominal cavity.

**Clinical Significance**

It is imperative for a radiologist to look for atypical features for the lesion in question, and to raise the possibility of underlying malignancy due to the vast differences in prognosis, treatment, and follow-up.. This is particularly so in the case of well-differentiated...
liposarcoma, which may mimic a simple lipoma. Wide local excision and long-term follow-up (> 5 years) are advocated for well-differentiated liposarcomas because of the high rate of local recurrence and potential for delayed dedifferentiation, and hence subsequent risk for metastasis.

Understanding and recognition of the radiologic spectrum of appearances of the various types of musculoskeletal liposarcomas facilitate radiologic assessment, which impact on subsequent management of the patient.
Fig. 1: The lesion in the subcutaneous fat of right arm in this 55-year-old man has signal intensity and character identical to that of the subcutaneous adipose tissue on T1-weighted (a) and T2-weighted fat saturated images (b). (c) Post contrast T1-weighted fat saturated images show thin enhancing septae within it, which can be seen with both benign lipomas and atypical lipomatous lesions.

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Fig. 2: Well-differentiated liposarcoma in a 89-year-old man who presented with a slowly enlarging, painless left thigh mass. (a) Coronal T1-weighted MR images demonstrate a high-signal-intensity adipose lesion that contains thin and thick septa (arrows) and several areas of mild nodularity (arrowhead). (b) Coronal T2-weighted fat saturated MR image shows high signal intensity in the thick septa and other areas of fat suppression. (c) Axial post contrast fat saturated T1-weighted images reveal numerous thick (>2mm) enhancing septa (arrow) and also encasement of the neurovascular bundle (arrowhead). (d) Lateral radiograph shows the same soft tissue mass with radiolucent fat (arrow).

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Fig. 3: Well-differentiated liposarcoma in a 36-year-old man who presented with a painless thigh mass. (a) Axial T1-weighted MR image shows intramuscular mass having predominant fat signal intensity with thick septa (arrowhead) and a nodular nonlipomatous focus of intermediate signal intensity (arrow). (b) Axial T2-weighted fat saturated MR image shows high signal intensity in the septa and nodular nonlipomatous focus (arrow), with other areas of fat saturation. (c) Axial contrast enhanced, fat-suppressed, T1-weighted MR images demonstrate enhancement of the septa and focal nonlipomatous nodular region (arrow).

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**Fig. 4:** Recurrent dedifferentiated liposarcoma of the thigh in a 81-year-old man with history of radical excision for a well differentiated liposarcoma 3 years back. (a) and (b) Axial T1 and T2-weighted images reveal a recurrent nodule (arrows) at the site of previous surgery which is composed of lipomatous and non lipomatous components. (c) Axial T1-weighted fat saturated post contrast image reveals heterogenous enhancement within the nodule and subjacent muscle suggesting infiltration. Separately seen are two lipomatous nodules which show signal drop-out on these fat saturated images (arrow heads).

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Fig. 5: Myxoid liposarcoma in the proximal thigh in a 52-year-old man with a slowly enlarging mass (a) Coronal T1-weighted (b) and T2-weighted fat saturated MR images reveal a mass of predominantly high-water content (low signal intensity with T1-weighting and very high signal intensity with T2-weighting). Few nodular foci (arrows) of tissue similar or identical to subcutaneous fat are identified on T1-weighted images. (c) On post contrast T1-weighted fat saturated images the mass shows peripheral nodular enhancement.

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Fig. 6: Myxoid liposarcoma with prominent round cell component in a 35-year-old female who presented with a slowly enlarging, painless mass in the subcutaneous and deep tissues of the distal thigh. (a) Coronal T1-weighted MR image show a relatively well-defined homogeneous mass with low to intermediate signal intensity (b) On T2-weighted axial fat saturated MR image the mass appears heterogenously hyperintense. No fat is apparent. (c) Although the imaging characteristics simulate a cyst, the mass shows avid and heterogenous enhancement on post contrast images. Post contrast imaging and ultrasound are helpful in diagnosing myxoid tumours which masquerade as a cyst on conventional MR sequences.

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Fig. 7: Pleomorphic liposarcoma in the right anterior chest wall in a 78-year-old man with a 1-year history of a rapidly enlarging, painless mass. (a-c) Axial T1-weighted MR images obtained before (a) and after (also with fat suppression) (c) contrast enhancement and an axial T2-weighted MR image (b) show a large intramuscular mass. The predominant portion of the mass reveals nonspecific, intermediate signal intensity on T1-weighted image and hyperintense signal intensity on T2-weighted image. Few foci of intralesional fat are seen (arrows). Other areas demonstrate intense post contrast enhancement (c).

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**Fig. 8:** Myxoid liposarcoma with component of well differentiated liposarcoma in a 92-year-old man whose presented with hard left thigh swelling. T1-weighted MR images obtained before (coronal plane) (a) and after (also with fat suppression) (c) contrast enhancement and (b) T2-weighted fat-suppressed MR image show that the mass contains areas of adipose tissue (arrows). Other regions of nonspecific solid tissue are seen to enhance heterogenously. The signal intensity is not as high as that of typical myxoid tissue.

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Conclusion

MRI is an extremely useful imaging modality in distinguishing lipomas, lipoma variants, and well-differentiated liposarcomas.

The MR appearance of a discrete, homogenous fatty mass with few or no thin septa, with minimal or no contrast enhancement as well as minimal or no areas of high T2 signal can be confidently diagnosed as a simple lipoma. In such cases, further evaluation or follow-up is generally not required.

The distinction between lipoma and well-differentiated liposarcoma, however, is a frequent diagnostic dilemma. Alarm bells should ring whenever a fatty lesion does not demonstrate the above features to suggest benignity. There should be a high level of suspicion for underlying malignancy if a mass is larger than 10 cm, contains less than 75% fat, has thickened septa (>2mm), demonstrates globular and/or nodular nonadipose component(s) as well as shows prominent areas of enhancement.

Understanding and recognition of the spectrum of the appearances of various subtypes of liposarcoma will improve radiologic assessment and is vital for optimal patient management.

The unifying radiologic feature of these lesions is the finding of fatty tissue in the majority of lesions. However, it is the radiologic appearance of associated non-lipomatous components that often allows diagnosis of the specific subtypes of soft-tissue liposarcomas. Understanding and recognition of the spectrum of the appearances of various subtypes of liposarcoma will improve radiologic assessment and this is vital for optimal patient management.
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