

Superficial Soft-Tissue Masses of the Extremities¹

TEACHING POINTS

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Superficial soft-tissue masses are among the most common indications for imaging of the extremities. A broad array of benign and malignant processes may be manifested in palpable cutaneous or subcutaneous masses or nodules. Most such lesions are treated with surgical excision, but some may be conservatively managed. The lesions can be differentiated according to their location in one or more skin layers (epidermis, dermis, and subcutis), their histologic composition, and the associated anatomic abnormality or disease process. Because the imaging characteristics of many benign soft-tissue lesions overlap with those of malignant ones, knowledge of the patient's clinical history (including any laboratory test results) and direct visual examination of the lesion often are important for differentiation. Histologic analysis may be necessary to achieve a definitive diagnosis.

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Introduction

Cutaneous and subcutaneous masses of the extremities comprise a broad and potentially bewildering array of benign and malignant processes. It can be difficult to find a description of lesions of this type in the musculoskeletal radiology literature, because these lesions are rarely identified or classified according to their superficial location and because some of them are seen only by dermatologists, without radiologic evaluation. An understanding of the microscopic anatomy of the skin can aid in the formulation of a differential diagnosis (Fig 1). The skin consists of three layers: the epidermis, the dermis, and subcutaneous fat. The epidermis is the thinnest layer and is composed mainly of keratinocytes, with smaller populations of Langerhans cells, Merkel (neuroendocrine) cells, melanocytes, and unmyelinated axons. Underneath this layer lies the dermis, which consists of fibroblasts, endothelial and neural cells, and supporting elements such as a collagen matrix and the arrector pili muscles. The dermal layer also contains mast cells; macrophages; and specialized cells for hair growth, temperature regulation, and epithelial renewal. The apocrine glands secrete an oily fluid and are affected by catecholamines, while the eccrine glands secrete sweat. Both types of glands begin in the dermis and end at the skin surface. Beneath the dermis lies the subcutis or subcutaneous fat layer, which consists of lipid cells, nutrient vessels, and thin septa (1,2).

From this myriad of cell types, a wide variety of benign and malignant soft-tissue lesions may arise. **Many of the malignant lesions may resemble benign ones at computed tomography (CT) and magnetic resonance (MR) imaging. Knowledge of the patient's clinical history and pertinent laboratory test results, as well as an active dialogue with the referring physician, may enable a more concise differential diagnosis.** The radiologist should be familiar with the anatomic and histologic features, as well as the imaging characteristics, of these lesions.

The article provides a concise review and description of benign and malignant soft-tissue lesions that arise in the epidermis, dermis, and subcutis as a result of disease, inflammation, or trauma.

Lesions of the Epidermis

Various lesions may arise from neural cells in the epidermal and dermal layers. Superficial neurofi-

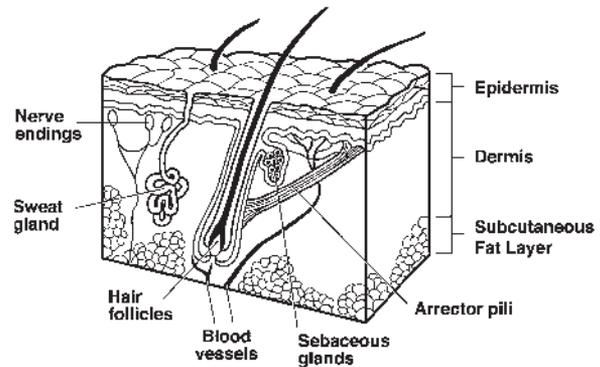


Figure 1. Schema shows the layers and specialized structures of the skin.

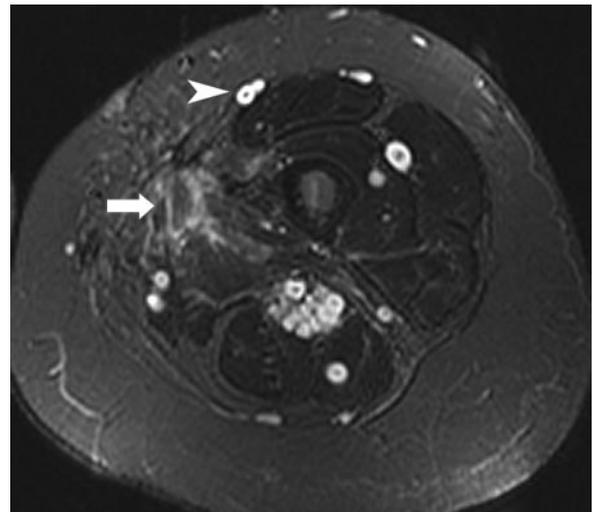
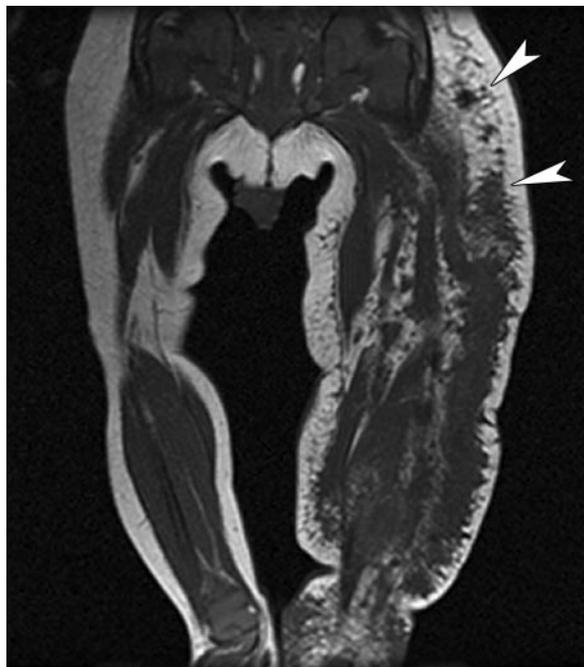
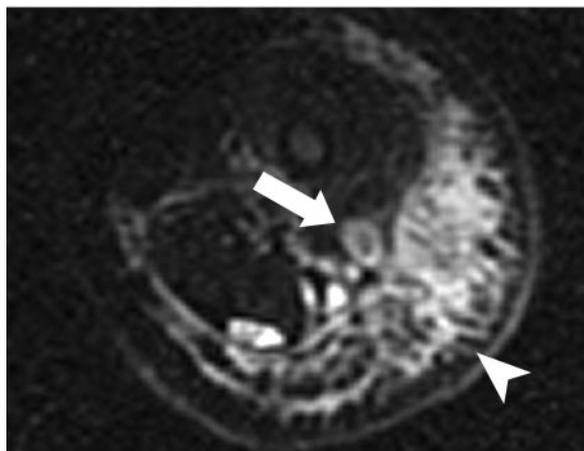


Figure 2. Type 1 neurofibromatosis in a 16-year-old girl. Axial T2-weighted fat-suppressed MR image of the thigh shows a subcutaneous neurofibroma (arrowhead) with a low-signal-intensity central target sign and the excision site (arrow) of a previous neurofibrosarcoma.

bromas may occur in the subcutaneous fat layer as well as the dermal and epidermal layers of the skin. In one study of patients with type 1 neurofibromatosis, 94% of superficial lesions extended to the skin surface (3). However, most single neurofibromas are not associated with neurofibromatosis. The nodular type of superficial neurofibroma in both the superficial and the deeper locations sometimes can be distinguished from other cutaneous masses by virtue of the "target sign," a central zone of low signal intensity seen on T2-weighted images. The central zone is composed of longitudinal bundles of residual nerve fibers or dense collagen and fibrillary tissue, which may account for the low signal intensity there; and myxoid material may account for the higher pe-



a.



b.

Figure 3. Hemangiomatosis and lymphangiomatosis in a child. **(a)** Coronal T1-weighted MR image shows reticulation in the subcutaneous fat of the upper part of the left leg (arrowheads). **(b)** Axial inversion recovery MR image shows a large central vessel (arrow) and a branching pattern of reticulation (arrowhead).

ripheral signal intensity (3,4) (Fig 2). However, the target sign is seen in only approximately 21% of superficial lesions found in patients with type 1 neurofibromatosis. The most common MR appearance of superficial lesions in type 1 neurofibromatosis is a diffuse, poorly defined focus of heterogeneous signal intensity on T2-weighted images (3).

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Hemangiomas are described according to the predominant type of vessel from which they originate, as cavernous, capillary, arteriovenous, or venous hemangiomas. The most frequent subcutaneous type is a capillary hemangioma, which is composed of small vessels with flattened endothelium. These lesions are found in the epidermal and subcutaneous layers. Lesions are usually identified in infancy or childhood and may change in size. Cavernous hemangiomas are dilated blood-filled spaces and are frequently intramuscular in location. They may contain phleboliths and other calcifications that can be seen on radiographs. Arteriovenous hemangiomas are caused by abnormal communication of arteries and veins and may have a superficial or deep location. Some authors consider these lesions to be indicative of persistence of the fetal capillary bed. The deeper lesions may cause bruits and an arteriovenous shunt. Venous hemangiomas also may contain phleboliths and, when seen in the extremities, are intramuscular in location (5). MR images may demonstrate fatty elements within the tumor, as frequently occurs in cavernous hemangiomas. T2-weighted images may depict a serpiginous border and feeding vessels (5). It may be difficult to distinguish lymphangiomas from cavernous hemangiomas, as both are multilocular cystic spaces. MR images show cavernous spaces as well as a serpentine branching pattern in the lesions (Fig 3).

Granuloma annulare is the manifestation of a benign inflammatory process that may affect the epidermis, dermis, and subcutaneous fat layer of the skin. It is predominantly found in children and young adults and may occur in a localized, perforating, generalized, or subcutaneous form. The localized form, which is commonly seen in the upper and lower extremities, may be manifested as multiple nodular ringed skin eruptions. The generalized form is similar to the localized type but has a wider distribution. The perforating form may extend to and penetrate the epidermis (6). **The subcutaneous form is always seen in children and bears a close histologic resemblance to a rheumatoid nodule.** The peak age of occurrence of this form is 2–5 years. The lesion usually is a painless, solitary mass and often is found in the pretibial region. Spontaneous regression has been seen, and local or distant recurrence has occurred in 19%–75% of cases (7). MR images

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Figure 4. Granuloma annulare in a 9-year-old girl. (a) Lateral radiograph of the tibia shows a superficial soft-tissue mass in the pretibial region (arrowhead). (b) Axial CT image shows a soft-tissue lesion (arrow) with an irregular superficial margin and lower attenuation than that in muscle.

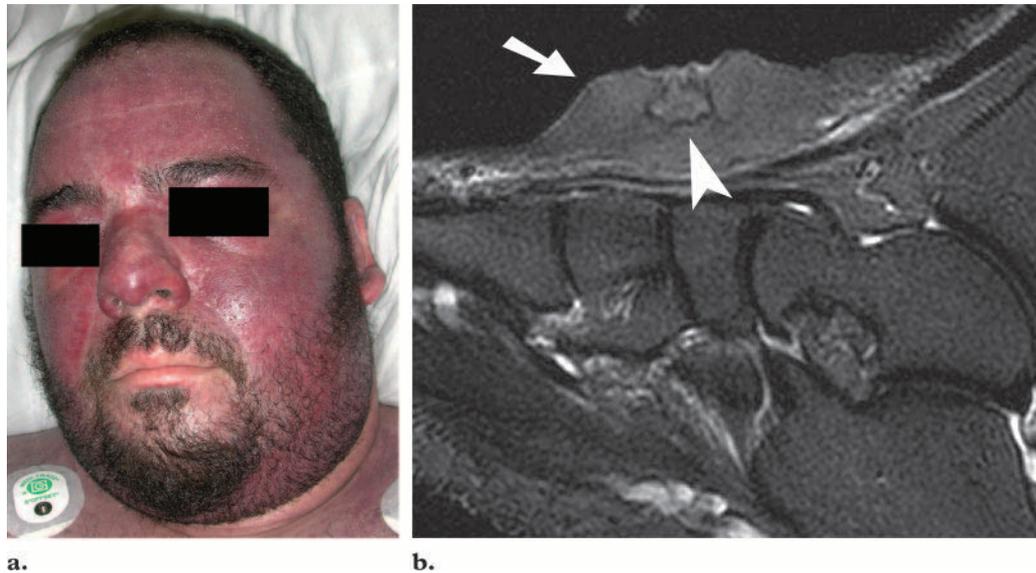
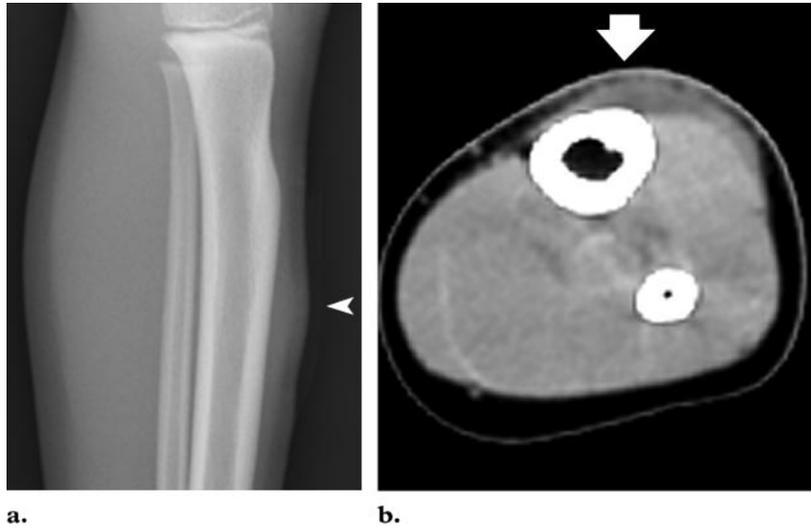


Figure 5. Leukemia cutis in a 29-year-old man with acute T-cell lymphoblastic leukemia. (a) Photograph shows a purple macular rash on the man's face and shoulders. (b) Sagittal T2-weighted image shows ulceration (arrowhead) in an intermediate-signal-intensity dermal and epidermal mass (arrow) on the dorsum of the foot.

depict an ill-defined subcutaneous mass (Fig 4) with a signal that is isointense on T1-weighted images and heterogeneously hyperintense on T2-weighted images when compared with the signal in muscle (7). Lesions that show low signal intensity on both T1-weighted and T2-weighted images also have been reported; the signal intensity difference in such cases may be due to the degeneration of collagen within the mass (6). Treatment usually consists of local excision. Since the nodules resemble those in rheumatoid arthritis, diagnosis may be aided by clinical and laboratory findings. Positive mucin staining is characteristic of granuloma annulare but not rheumatoid arthritis.

Leukemia cutis is defined as infiltration of the skin by leukemic cells, and its presence is associated with a grave prognosis (8). The epidermis, dermis, or subcutaneous fat layer, or some combination thereof, may be infiltrated by neoplastic leukocytes. A particular type of leukemia may be manifested in different types of skin lesions, even in the same patient: The clinical appearance of leukemia cutis may be that of ulcerative lesions, nodules, urticaria, or bullous lesions. Such lesions may be manifestations not only of leukemia but also of lymphoma (Fig 5).

Pigmented skin tumors are one of the most frequent reasons for dermatologic evaluation. MR imaging may be useful for differentiating melanoma from benign pigmented skin tumors such as blue nevi and intradermal nevi (9). Melanin has

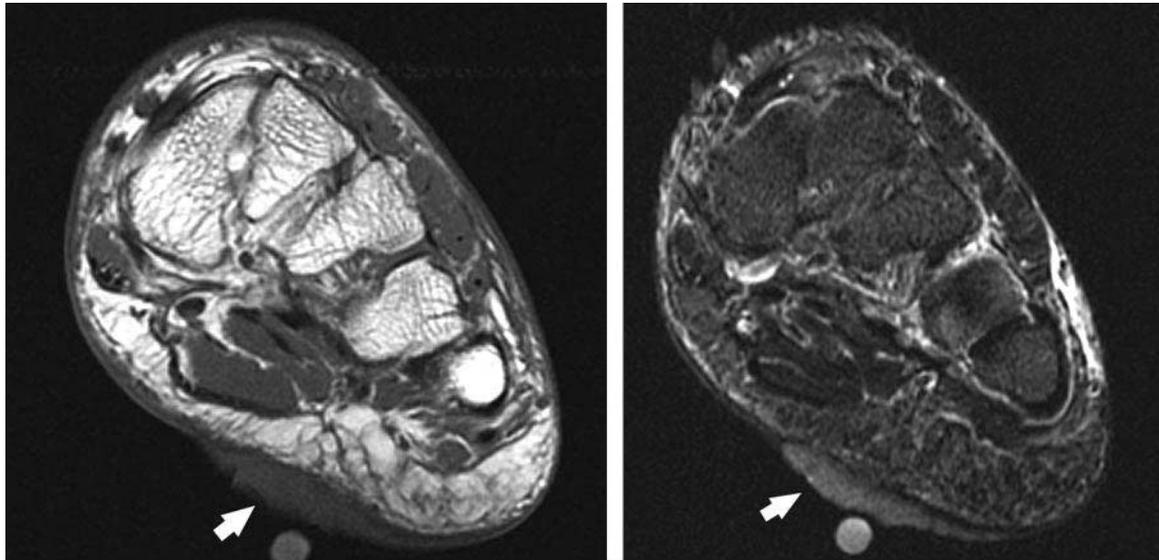


Figure 6. Primary melanoma on the plantar surface of the foot. **(a)** Short-axis axial T1-weighted MR image shows a low-signal-intensity neoplasm in the deep dermis and epidermis (arrow). The signal in the lesion is isointense or slightly hyperintense compared with that in muscle. **(b)** Short-axis axial T2-weighted MR image shows a mild, inhomogeneous increase in signal intensity in the lesion (arrow).

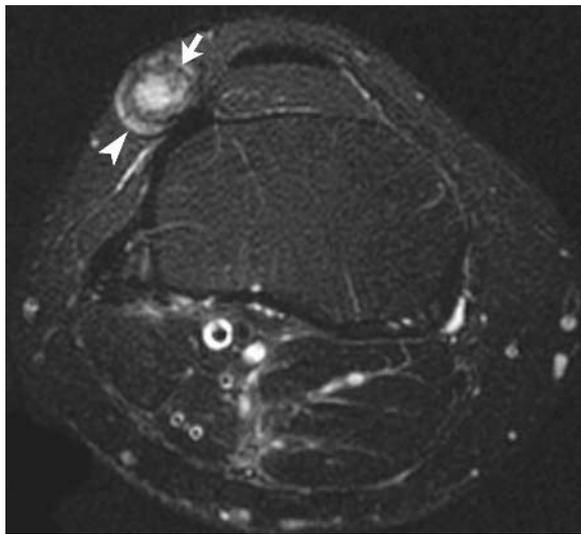


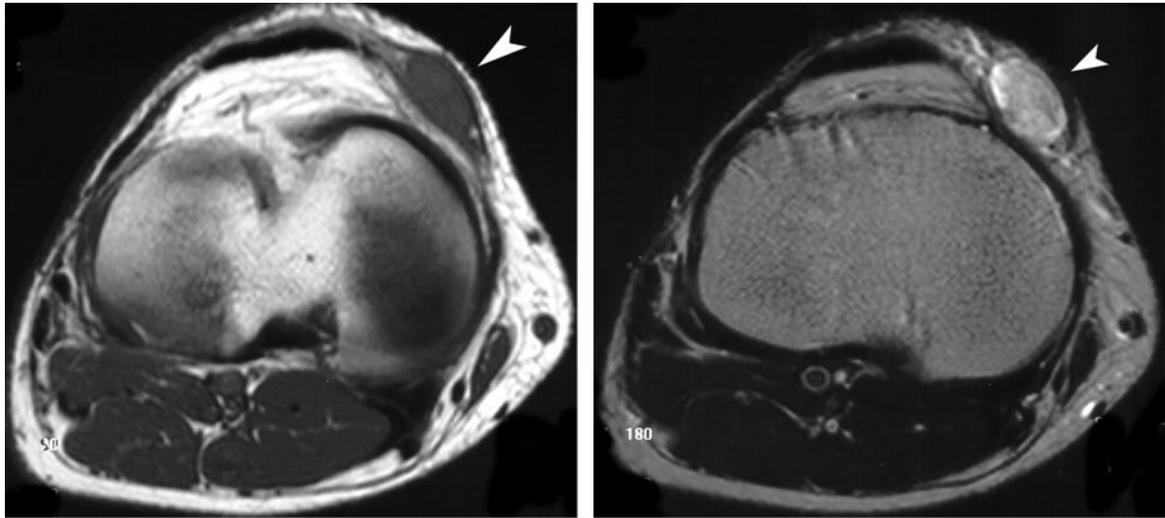
Figure 7. Ancient schwannoma in a 42-year-old woman. Axial T2-weighted fat-suppressed MR image shows a well-defined high-signal-intensity lesion (arrowhead) that contains a discrete central focus of necrosis with an ill-defined low-signal-intensity margin (arrow).

paramagnetic properties, and lesions with a higher melanin content have been shown to have higher or mixed signal intensity on T1-weighted images (10). In one small study, investigators showed that primary melanoma could be distinguished from metastatic melanoma and benign pigmented lesions by means of a tumor-to-fat contrast ratio calculated on the basis of the appearance of these lesions on T2-weighted images (9). In general, the T2-weighted signal intensity of malignant tumors was higher than that of sub-

cutaneous fat, whereas that of benign lesions was lower than that of subcutaneous fat. The higher T2-weighted signal intensity of malignant lesions may be secondary to the presence of hemorrhage (9). Other authors who investigated metastatic melanoma reported that, although there was no clear correlation between melanin content and signal intensity on T2-weighted images, a correlation was found between melanin content and T1 shortening (10) (Fig 6). In the same study, tumors with no visible melanin pigment at histologic analysis included a greater number of lesions with hypo- to isointense signal on T1-weighted images and mixed signal on T2-weighted images when compared with the signal in muscle (10).

Lesions of the Dermis

Schwannoma is a benign lesion that arises from the Schwann cells of the nerve sheath. The tumor may be eccentric and may displace the peripheral nerve. Schwannoma is most commonly found in adults between the ages of 20 and 50 years. Ancient schwannoma, also known as degenerative neurilemmoma, may be found in an older patient population because it is a lesion of long duration. Most reported cases in the extremities are found in deep locations (11), but superficial schwannomas may occur in the dermal layer (Fig 7). Symptoms of tenderness and numbness are frequently reported at initial presentation. Calcification and ossification, perivascular hyalinization, and cystic



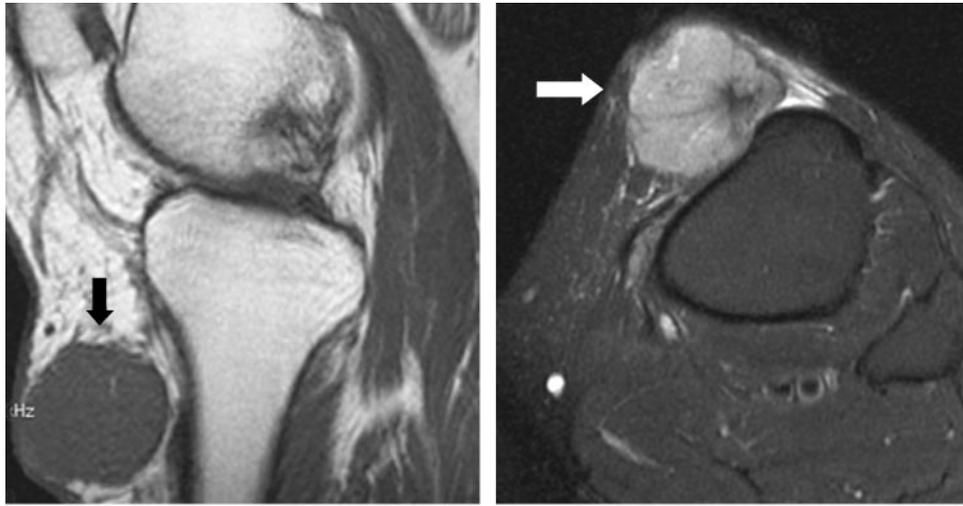
a. **Figure 8.** Cutaneous angioleiomyoma adjacent to the patella in a 26-year-old man. **(a)** Axial T1-weighted MR image shows a well-defined, homogeneous, oval lesion (arrowhead) that appears to have invaded the capsule. The results of a histologic analysis showed no capsular infiltration. **(b)** Axial T2-weighted fat-suppressed MR image shows heterogeneous high signal intensity in the lesion (arrowhead).

necrosis are seen at histologic analysis, but a mineralized matrix usually is not seen on radiographs. Degeneration is hypothesized to occur over a long time and is manifested on MR images as a focus of central necrosis, which may be surrounded by a fibrous capsule (Fig 7). The lesions are well circumscribed. Most schwannomas are composed of Antoni type A and type B cells; however, in ancient schwannomas, there is a loss of the type A cells and the tumor is composed largely of Antoni type B cells (11). Areas of necrosis may mislead the observer and cause a schwannoma to be misdiagnosed as a sarcoma (11).

Cutaneous angioleiomyoma is an uncommon neoplasm; angioleiomyomas are more frequently found in the uterus and the gastrointestinal tract (12). Dermatologists often treat cutaneous angioleiomyomas and, therefore, descriptions of the imaging features of this neoplasm are scarce in the literature (Fig 8). The lesions occur in the dermis and subcutis and may derive, in part, from the smooth muscle cells of the arrectores pilorum. Patients may present with one or more painful solitary subcutaneous nodules that are freely movable. The lesions are most frequently seen in the lower extremity and are associated with spontaneous sharp pain. Discomfort might be elicited by such diverse stimuli as a cold temperature or wind. The lesions occur more frequently in

women than in men, and pregnancy may increase the severity of pain. Some authors differentiate among solid, cavernous, and venous subtypes, but all subtypes contain benign-appearing smooth muscle cells and vascular channels. In rare cases, nuclear pleomorphism and mitotic figures have been reported in these lesions. Small nerve fibers may be present in the stroma or walls of these tumors; some investigators have hypothesized that such nerve fibers may be the source of pain. Complete excision of the lesion is the treatment of choice (12,13). The tumor may become malignant, degenerating into a superficial leiomyosarcoma, but this occurrence is rare; such lesions account for only 2%–3% of soft-tissue sarcomas.

Giant cell tumor of the soft parts is another rare neoplasm, with the largest reported series consisting of 22 cases (14). The neoplasm may be benign or malignant and has been observed in children and in adults up to 80 years old. The lesions are most commonly found in the deep dermis or subcutaneous fat layer, but adjacent muscle invasion has been seen. The lower extremity is the most frequent location, followed by the trunk. At histologic analysis, the soft-tissue lesions closely resemble their osseous counterparts. Areas of stromal hemorrhage and hemosiderin deposition have been noted in approximately 50% of the lesions. Metaplastic bone formation was seen in approximately 40% of the lesions in one case series (14). Malignant behavior is very rare and may be associated with atypical cells, including pleomorphic giant cells. Differential



a. **b.**
Figure 9. Giant cell tumor of the soft parts adjacent to the knee in a 71-year-old woman. **(a)** Sagittal T1-weighted MR image shows a round inhomogeneous lesion (arrow) in the subcutaneous fat. The lesion has higher signal intensity than that in muscle. **(b)** Axial T2-weighted fat-suppressed MR image shows mildly increased signal intensity in most of the lesion (arrow) and a low-signal-intensity focus that may reflect hemosiderin deposition.

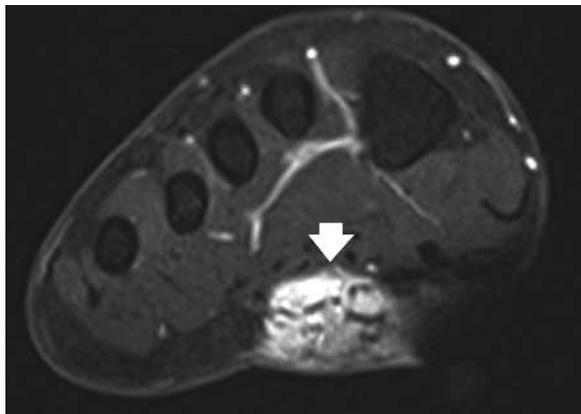


Figure 10. Dermatofibrosarcoma protuberans of the foot in a 33-year-old woman. Short-axis axial contrast-enhanced T1-weighted fat-suppressed MR image shows a lesion with marked inhomogeneous enhancement (arrow). The results of a histologic analysis demonstrated the penetration of the lesion through the dermis and subcutaneous fat layer to the fascia.

diagnosis, based on histologic findings, includes giant cell-rich extraskeletal osteosarcoma and giant cell-rich malignant fibrous histiocytoma (15). The recurrence rate for giant cell tumor of the soft parts, at approximately 6%, is lower than that for its osseous counterpart (14). Low-signal-intensity foci within the lesions on T1-weighted and T2-weighted images have been documented and may reflect hemosiderin deposition (Fig 9) (16,17).

Dermatofibrosarcoma protuberans is a superficial neoplasm that arises in the dermis, but large lesions may extend into the deeper soft tissues. Lesions are seen most commonly in the trunk but have been observed in both the upper and the lower extremities. Patients may present with an indurated plaque that, over the course of several years, may develop into an ulcerated nodule (18). Males are more often affected than are females, and the tumor most commonly is seen in the 2nd through 5th decades of life. Childhood dermatofibrosarcoma protuberans also has been reported, and in this age group the lesion is found in the hands or feet (18). Local recurrence may be seen after resection, but metastases are rare. The neoplasm contains spindle cells arranged in a storiform pattern. The MR appearance of the neoplasm is nonspecific, with signal often isointense to that of muscle on T1-weighted images and signal intensity higher than that of fat on T2-weighted images (Fig 10) (19).

Epithelioid sarcoma may be manifested as a subcutaneous mass or a nonhealing ulcer. The lesions begin in the dermis, and, in areas like the finger, where there is little subcutaneous fat, they may ulcerate through the skin surface. They may be painless and slow growing and therefore easily ignored in the early stages of disease. Tumors

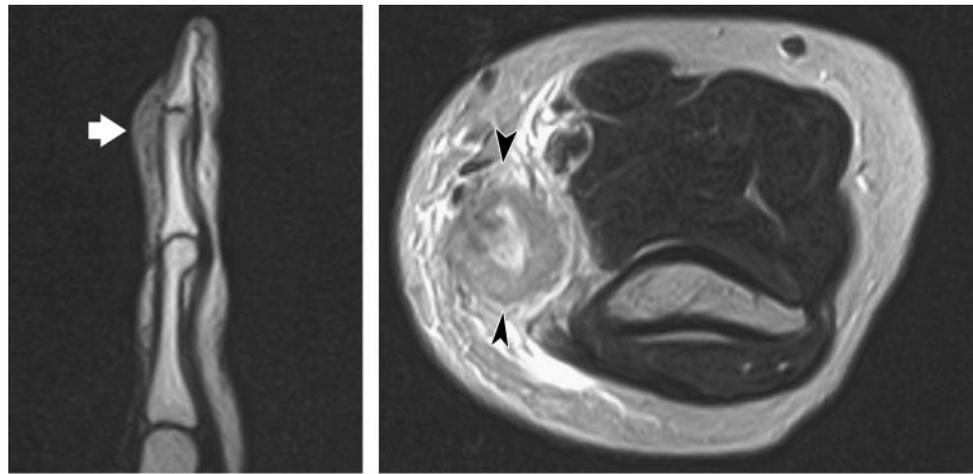
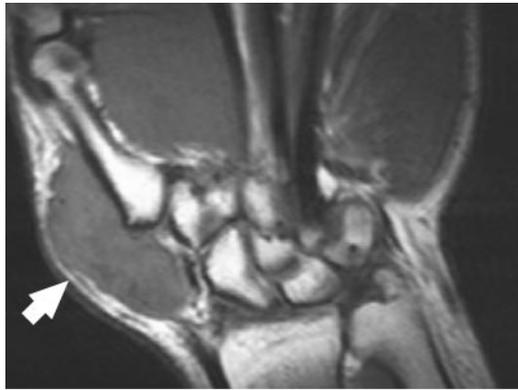


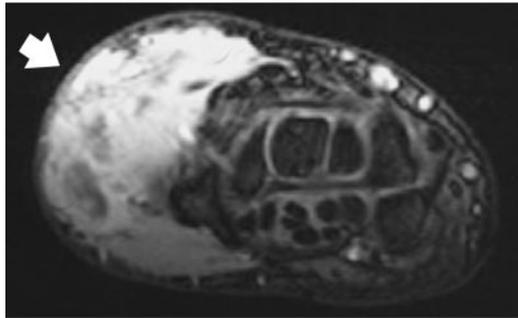
Figure 11. Epithelioid sarcoma in the finger of a 52-year-old man. **(a)** Sagittal T1-weighted MR image shows a heterogeneous low-signal-intensity neoplasm on the dorsal surface of the finger at the level of the middle phalanx (arrow). **(b)** Axial T2-weighted fat-suppressed MR image of the ipsilateral elbow shows an enlarged lymph node with inhomogeneous signal intensity (arrowheads).

occur in the distal parts of the extremities, particularly the hand and forearm, in young adults (Fig 11a). Patients also may demonstrate palpable lymphadenopathy in the affected extremity (Fig 11b), and this event should prompt a search for potential tumor satellites at diagnosis. Regional lymph node dissection is recommended, and amputation of the digit is considered if a tumor is found in the finger or toe (20). Radiographs may depict focal cortical thickening or stippled soft-tissue calcification. The tumor has a variable appearance on MR images: It may be well marginated and homogeneous in a superficial location but infiltrative and heterogeneous in a deeper location (21). Deep-seated tumors may attach to tendon sheaths, fascias, and tendons or may spread along neurovascular bundles and quickly disseminate disease (21). Histologic analysis reveals large polygonal epithelioid cells with eosinophilic cytoplasm and vesicular nuclei. Wide infiltrative margins and a variable degree of nuclear pleomorphism and necrosis may be observed. Reported local recurrence rates are as high as 77%, and both recurrence and metastasis may take place many years after an initial resection (21).

Cutaneous adnexal tumors consist of a broad range of benign and malignant neoplasms. Lesions are classified according to their site of origin in the apocrine, eccrine, or sebaceous glands. Many of the lesions behave in a benign manner, but almost all have a carcinomatous counterpart. As the tumors are slow growing and asymptomatic, medical attention commonly is not sought until significant local invasion by malignant lesions has occurred (22). Eccrine gland carcinomas are firm subcutaneous nodules that occur in adults across a broad age range (18–80 years). The 5-year survival rate is approximately 60%. Eccrine glands are found everywhere on the body, except the lips and parts of the genitalia. Immunohistochemical analysis may help differentiate the carcinomatous variants of cutaneous adnexal tumors from other skin carcinomas. Duct formation may be seen, with islands of malignant cells. The MR imaging appearance of the nodules is nonspecific (Fig 12). Primary therapy is surgical resection with a wide margin; but even with a wide margin, death may occur months or years after an initial resection, secondary to lymph node involvement or distant metastases. Radiation therapy has been used with moderate success for local control, but chemotherapy is still under investigation (23).



a.



b.

Figure 12. Sweat gland carcinoma in the hand of a 40-year-old man. **(a)** Coronal T1-weighted MR image shows an inhomogeneous mass (arrow) adjacent to the first metacarpal bone. **(b)** Axial contrast-enhanced T1-weighted fat-suppressed image shows the inhomogeneous enhancement and ill-defined edges of the mass (arrow).

Merkel cell carcinoma is a rare aggressive neuroendocrine tumor. The Merkel cell is found in the epidermis, where it is associated with a flattened axon terminal plate and may function as a mechanoreceptor for touch. As the neoplasm originates in the dermis and only rarely involves the epidermis, its origins have been questioned. Neurosecretory granules found in tumor cells suggest that the tumors derive from Merkel cells (24).

Patients may present with painless red or violaceous nodules on sun-exposed skin. The age range for incidence of this tumor is wide, but most cases occur in adults older than 65 years. There is an increased incidence of this neoplasm in immunosuppressed patients with leukemia, an



Figure 13. Merkel cell carcinoma in the upper arm of a 64-year-old woman. Sagittal T1-weighted MR image shows an ill-defined lesion (arrow) located in the subcutaneous fat and extending to the dermis. The lesion has signal isointense to that in muscle and hypointense to that in adjacent fat. The subcutaneous fat stranding is indicative of inflammation.

organ transplant, or rheumatoid arthritis. Tumors in the immunosuppressed population also may be found in patients younger than 65 years (25). At histologic analysis, the tumor cell nuclei contain finely dispersed chromatin and have rounded contours. These features are helpful in eliminating melanoma, lymphoma, and cutaneous small cell epithelioid tumors from the differential diagnosis (26).

CT and MR images may show inflammatory fat stranding adjacent to the lesion (Fig 13) (27, 28). Other MR findings may include additional skin and subcutaneous tumor nodules aligned in a row and adjacent large lymph node masses. MR imaging may be useful for evaluating patients for lymphatic involvement. Adjacent lymph node metastases were seen on MR images in 33% of patients in one case series (28). Compared with muscle, the lesions showed signal that was isointense or slightly hyperintense on T1-weighted

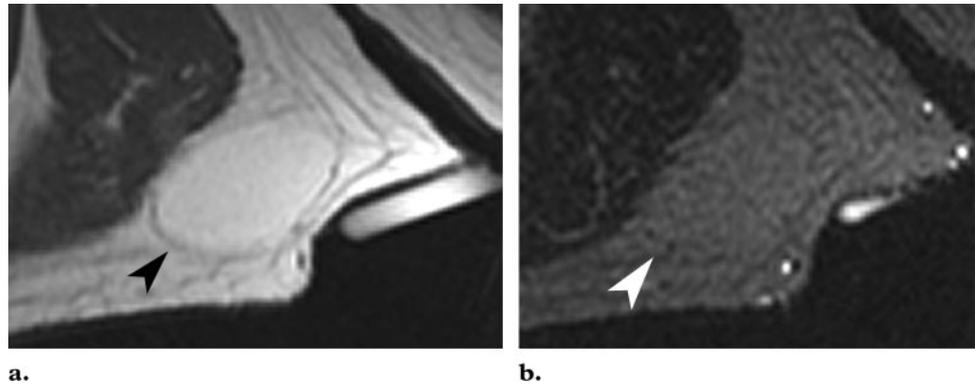


Figure 14. Lipoma in the subcutaneous fat layer in the shoulder of a 30-year-old man. Axial T1-weighted MR image (**a**) and axial T2-weighted fat-suppressed MR image (**b**) show a discrete soft-tissue mass with internal signal intensity identical to that of fat (arrowhead) and, in **a**, a surrounding thin rim of low signal intensity that represents a capsule.

images and hyperintense on T2-weighted images. Large masses showed an inhomogeneous signal on T2-weighted images (28). The prognosis is poor, although there are reported cases of spontaneous regression of the neoplasm and lymph node metastases, a process that is believed to be mediated by T-cell immunity. The response to chemotherapy may be short lived. The overall local recurrence rate is 25%, and regional lymph node metastasis occurs in an estimated 52% of cases. The disease takes a more aggressive course in transplant recipients, and 56% of those affected eventually die of the disease (25).

Cutaneous metastases are often harbingers of advanced disease. The distribution of cutaneous metastases roughly parallels the overall incidence of visceral malignancies in the general population. In a study of Veterans Administration patients, cutaneous metastases from lung cancer, melanoma, colon cancer, and genitourinary cancers were seen most frequently (29). Approximately 75% of patients in the study population had a primary malignancy and widespread disease. Metastatic lesions usually were observed in close proximity to the primary lesion site. Only 18% of metastases occurred in the extremities, and these were most frequently from melanoma. Metastases from lung cancer and melanoma usually were confined to the dermis, and lesions of all types in most cases spared the epidermis (29). To our knowledge, there is no description of these lesions

in the radiology literature, nor is it known how frequently cutaneous metastases demonstrate characteristics of the index neoplasm. We have observed that the metastatic lesions vary in appearance.

Lesions of the Subcutaneous Fat Layer

Lipomas are the most common soft-tissue neoplasm, and superficial lipomas account for approximately 16%–50% of soft-tissue tumors. Superficial lipomas mainly are found in the subcutaneous fat layer, but lipomas also may occur in deep locations beneath the superficial fascia. Deep lipomas of the extremities are usually intramuscular or infiltrating and may reach a much larger size than do superficial lipomas. A superficial lipoma usually is soft and mobile on physical examination and is rarely larger than 5 cm in diameter. On MR images, lipomas have signal intensity similar to that of adjacent subcutaneous fat. The lesions are separated from the subcutaneous fat by a thin capsule and may contain thin septa (30) (Fig 14).

Another lesion thought to derive from Schwann cells is the granular cell tumor, which occurs in both benign and malignant forms. Most benign lesions are found in the subcutaneous fat layer of the extremities, are 4 cm or less in size, and have a round or oval shape. A granular cell tumor of the benign subtype may have low signal intensity on T1-weighted and T2-weighted images (Fig 15), a feature that makes it indistin-

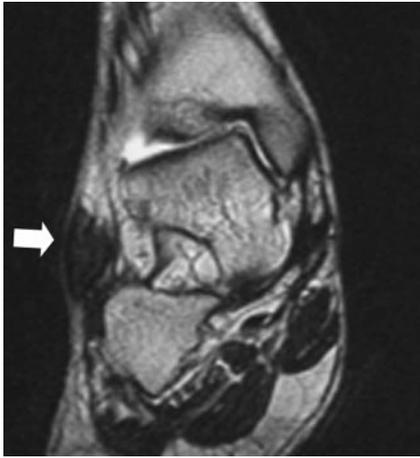


Figure 15. Granular cell tumor in a 24-year-old woman. Coronal T2-weighted MR image shows an oval lesion with low signal intensity (arrow) in the subcutaneous fat of the foot, near the heel.

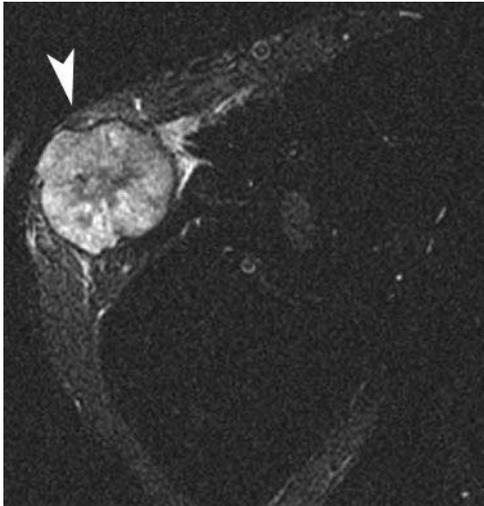


Figure 16. Subcutaneous nodular fasciitis in a 33-year-old man. Axial T2-weighted inversion recovery MR image shows a lesion (arrowhead) with a lobular contour, a thin surrounding capsule, and a low-signal-intensity core in the subcutaneous fat layer adjacent to the fascia.

guishable from a benign fibrous tumor. A peripheral rim of high signal intensity in benign lesions on T2-weighted images also has been reported (31). Literature about the imaging appearance of

the malignant subtype is scarce. A size of more than 4 cm, a location in the deep soft tissues, and infiltration of adjacent structures have been cited as malignant characteristics. Malignant tumors also may have a more inhomogeneous signal intensity than do benign tumors on T2-weighted images (31). Histologic evaluation reveals a prominent stromal component in the tumors and a ribbonlike arrangement of tumor cells, both of which may account for the low signal intensity seen on MR images (31).

Nodular fasciitis is a common soft-tissue neoplasm in young and middle-aged adults. Its most frequent manifestation is a subcutaneous nodule, but larger intramuscular forms also have been reported. Lesions may be tender or painful and are seen most frequently in the upper extremity, specifically the forearm (32). On T1-weighted images they may demonstrate a signal that is isointense or hyperintense to that of muscle. On T2-weighted images, they may have signal that is hyperintense to that of muscle (Fig 16). Lesions appear round or oval and usually are well circumscribed (33,34). Histologic examination may reveal hypercellularity, with plump fibroblasts arranged in fascicles (33). Some authors believe that the MR imaging characteristics of the lesions change according to the stage of their development. A myxoid matrix is visible in the early stage of formation. As the lesion matures, cellularity increases. Lesions of both histologic types may demonstrate high signal intensity on T1- and T2-weighted images. Mature lesions often are characterized by increased fibrosis, and the fibrotic areas have low signal intensity on T1- and T2-weighted images (34). Treatment is excision, and there is a low rate of recurrence.

Malignant fibrous histiocytoma is the most common soft-tissue sarcoma and is found most frequently in the thigh. In one large case series, subcutaneous tumors constituted 43% of the lesions (35). Superficial subcutaneous tumors are smaller, and the superficial location implies a better prognosis. Such tumors may be confined to the subcutis or extend from the subcutis to the fascia (36). The longer overall survival of patients with superficial tumors may be related to the higher incidence in this group of tumors of the

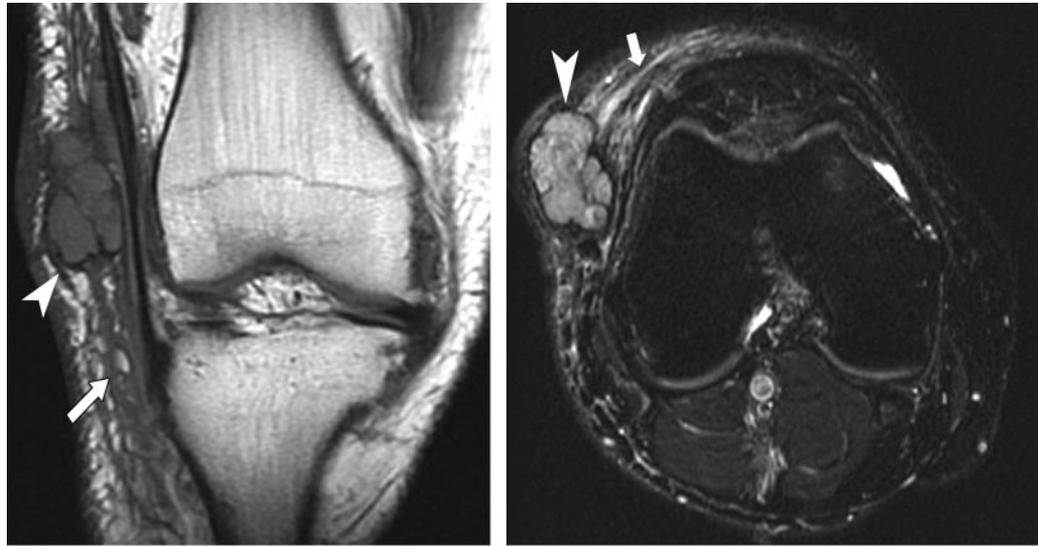


Figure 17. Superficial malignant fibrous histiocytoma in a 44-year-old man. **(a)** Coronal T1-weighted MR image shows a multilobulated low-signal-intensity lesion in the subcutaneous fat (arrowhead) adjacent to the iliotibial band, with edema (arrow) in the surrounding soft tissue. **(b)** Axial T2-weighted fat-suppressed MR image shows inhomogeneous high signal intensity in the tumor (arrowhead) and the surrounding region of soft-tissue edema (arrow).

myxoid subtype, which is associated with a lower incidence of metastases, as well as to lesion size (35). Histologic subtypes include myxoid, storiform, pleomorphic, and inflammatory patterns. The storiform subtype is the one most commonly found in the extremity (37).

MR imaging of soft-tissue malignant fibrous histiocytomas reveals lesions with intermediate to low signal intensity on T1-weighted images and inhomogeneous high signal intensity on T2-weighted images (Fig 17). Images depict calcification in 5%–20% of the lesions. High-grade myxoid lesions may appear cystic, and images acquired after the administration of gadolinium reveal the nodular nonmyxomatous elements in tumors of this type (37).

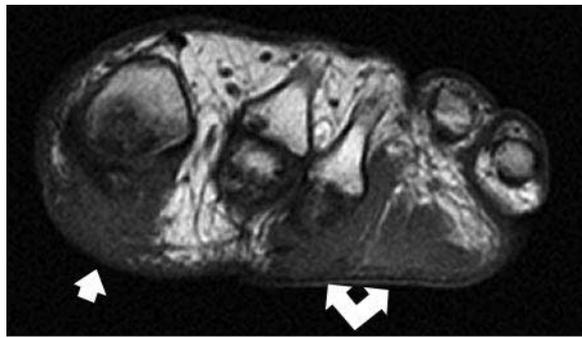
Synovial sarcomas account for approximately 10% of all soft-tissue sarcomas. The 10-year survival rate for patients with these lesions is 11%–58%. Superficial lesions generally occur in the distal portions of the extremities or in para-articular locations (38). The mean age at occurrence is 30 years. Favorable clinical factors include young age of the patient, tumor size of less than 5 cm, and tumor location in the distal part of the extremity (39). Several types of synovial sarcoma have been recognized, including biphasic, monophasic epithelial, monophasic fibrous, and poorly differentiated synovial sarcomas. Monophasic



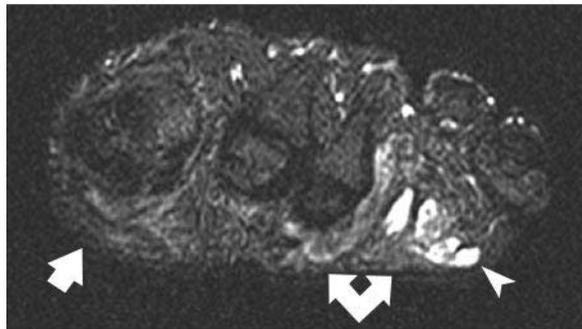
Figure 18. Synovial sarcoma. Sagittal T2-weighted fat-suppressed MR image shows a well-defined homogeneous high-signal-intensity lesion (arrowhead) with internal septa. The lesion is located on the superficial surface of the Achilles tendon.

tumors in the distal extremities imply a worse prognosis than do tumors of the biphasic type (38).

Soft-tissue calcification is seen in approximately 30% of synovial sarcomas. MR images



a.



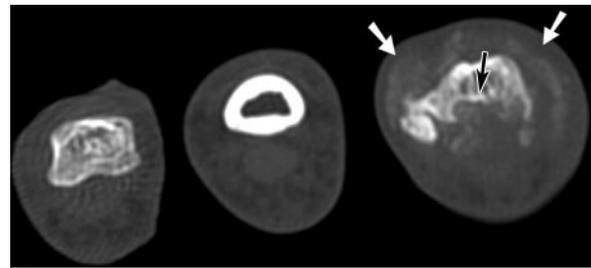
b.

Figure 19. Rheumatoid arthritis. (a) Short-axis axial T1-weighted MR image of the foot shows low-signal-intensity rheumatoid nodules (arrows) under the metatarsal heads. (b) Short-axis axial T2-weighted inversion recovery image shows low signal intensity in most of the nodules (arrow), with peripheral areas of high signal intensity in the lateral lesions (conjoined arrows). Adventitial bursitis adjacent to the lateral nodules (arrowhead) also is visible.

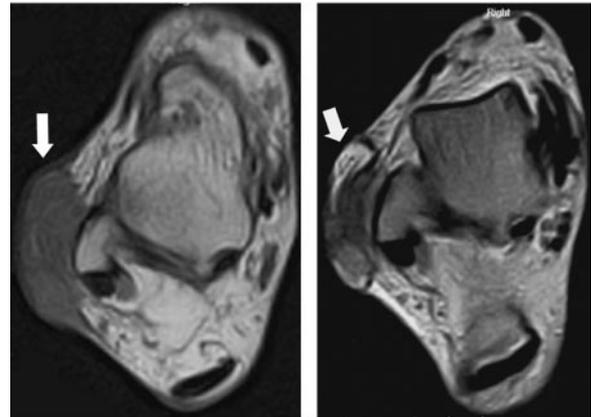
may demonstrate complex signal characteristics, with fluid levels, hemorrhage, and septation in the lesions. Neoplasms with a diameter of less than 5 cm may have a more benign appearance, with well-circumscribed margins and homogeneous high signal intensity on T2-weighted images (Fig 18) (40).

Inflammation-induced Lesions

Inflammatory processes such as gout and rheumatoid arthritis may produce lesions in both bone and soft tissue. Rheumatoid nodules frequently are seen in the subcutaneous soft tissues near pressure points and prominent bones, such as the heel pad. These soft-tissue lesions are easily diagnosed if there is radiographic evidence of arthritis in the adjacent joint. The MR appearance of rheumatoid nodules may vary from low signal intensity on both T1- and T2-weighted images to heterogeneous increased signal intensity on T2-weighted images (Fig 19). Heterogeneous increased signal intensity has been noted in nodules with central necrosis (41). These nodules also



a.



b.

c.

Figure 20. Gout. (a) Axial CT image of the hand of a 44-year-old woman shows calcification in tophi (white arrows) and a well-defined area of erosion (black arrow) in a phalanx. (b) Axial T1-weighted MR image of the ankle of a 56-year-old man shows an intermediate-signal-intensity tophus adjacent to the lateral aspect of the fibula (arrow). (c) Axial T2-weighted MR image of the ankle shows a tophus (arrow) with both high- and low-signal-intensity components.

may communicate with bursal sacs. Like rheumatoid arthritis, tophaceous gout may result in the formation of nodular soft-tissue masses that may contain calcification (Fig 20a). Low signal intensity may be observed in the tophi on both T1- and T2-weighted images (Fig 20b, 20c); however, signal intensity characteristics are nonspecific, as high signal intensity on T2-weighted images also has been reported (42).

Kimura disease is an inflammatory disorder that is seen most frequently in Asian males who are in their 2nd or 3rd decade of life. Patients present with painless masses, eosinophilia, and high serum IgE concentrations. Subcutaneous masses are seen most frequently in the head and neck and often involve the major salivary glands and regional lymph nodes. Upper-extremity masses also have been reported to occur in the epitrochlear regions. The etiology of this disease

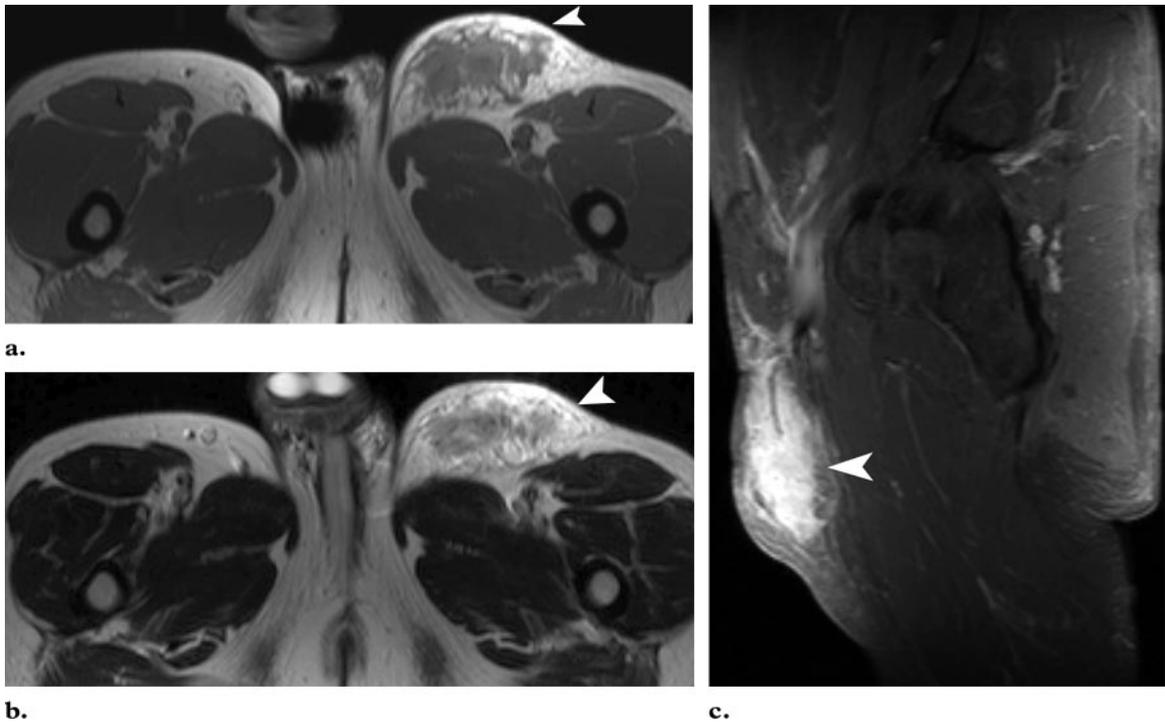


Figure 21. Kimura disease. (a) Axial T1-weighted image shows an inhomogeneous subcutaneous lesion in the thigh, with signal intensity higher than that of muscle (arrowhead). Fat stranding is visible at the lesion margin. (b) Axial T2-weighted image shows a peripheral region of high signal intensity and a central region of low signal intensity in the lesion (arrowhead). (c) Sagittal contrast-enhanced T1-weighted fat-suppressed image shows an ill-defined enhanced mass in the groin (arrowhead).

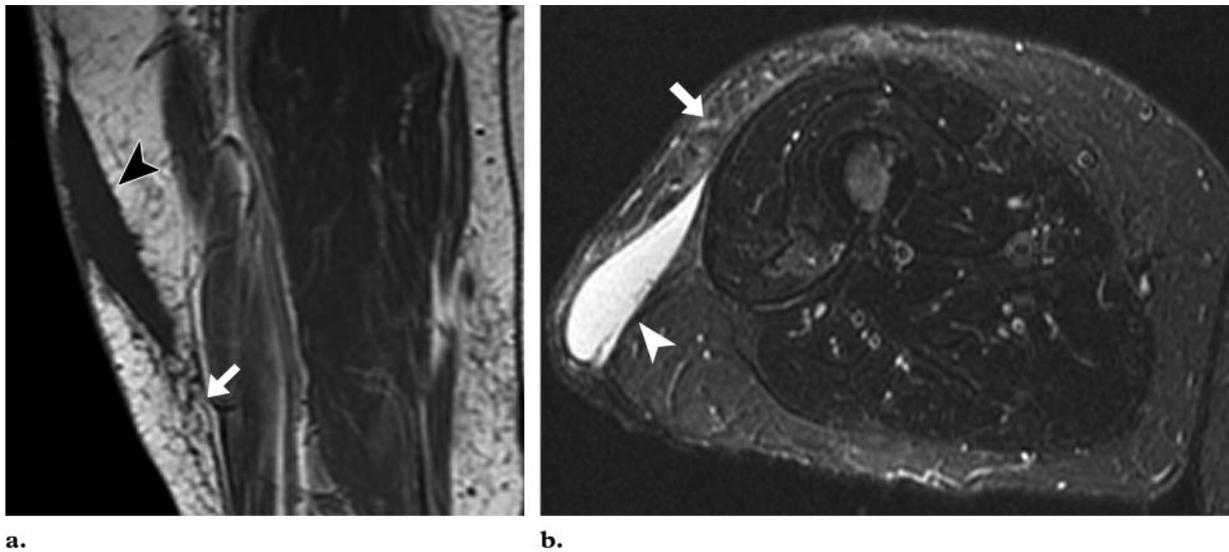


Figure 22. Morel-Lavallée lesion in a 52-year-old woman after a motor vehicle accident. (a) Coronal T1-weighted MR image shows a fusiform homogeneous low-signal-intensity lesion in the subcutaneous fat layer (arrowhead) adjacent to the fascia. Fat stranding (arrow) also is visible. (b) Axial T2-weighted fat-suppressed image shows a fluid collection with a well-defined superficial margin and internal debris (arrowhead), as well as fat stranding (arrow).

is unclear, but laboratory findings are suggestive of an autoimmune response to an unknown stimulus. MR images may demonstrate bulky, poorly marginated subcutaneous soft-tissue masses with signal that is isointense to or slightly higher in intensity than the signal of muscle on T1-weighted images. Lesions all have high signal intensity relative to that of muscle on T2-weighted images and are homogeneously enhanced (Fig 21). The masses are composed of enlarged lymph nodes with eosinophilic infiltration in the paracortical areas, increased postcapillary venules, and hyperplastic lymphoid follicles. Treatment may include surgical excision if conservative management with steroids is not effective. The rate of recurrence is as high as 25% after treatment with surgery alone, but malignant transformation has not been reported (43,44).

Trauma-related Lesions

Trauma-induced soft-tissue masses most often are found in locations adjacent to prominent bones. Some patients, particularly children, do not recall the occurrence of injury. The subcutaneous fat layer may demonstrate a variety of signal intensity changes that correspond to the stages of fat necrosis. Linear areas of edema with high signal intensity are commonly seen on T2-weighted images, but no well-demarcated soft-tissue mass is visible. In a chronic lesion, areas of low signal intensity appear on T1-weighted and T2-weighted images as fibrosis and hemosiderin deposits accrue in the injured areas (45). If the patient has experienced high-velocity trauma, internal degloving may take place around the pelvis, a condition that produces a Morel-Lavallée lesion. The skin and subcutis separate from the fascia, producing a cavity that is filled with fluid and debris. Lesions are found around the thigh and have a well-defined oval or fusiform shape. They are usually partially or wholly encapsulated (Fig 22). Signal intensity may change from that seen in a hemorrhage to that typical in a seroma, depending on the chronicity of the lesion. Patchy internal or peripheral enhancement also may be seen (46).

In summary, superficial soft-tissue masses are manifestations of a wide variety of benign and malignant processes. Knowledge of the patient's clinical history and direct visual examination of the lesion may help narrow the differential diagnosis.

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Superficial Soft-Tissue Masses of the Extremities

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Page 1290

Many of the malignant lesions may resemble benign ones at computed tomography (CT) and magnetic resonance (MR) imaging. Knowledge of the patient's clinical history and pertinent laboratory test results, as well as an active dialogue with the referring physician, may enable a more concise differential diagnosis.

Page 1291

The target sign is seen in only approximately 21% of superficial lesions found in patients with type 1 neurofibromatosis. The most common MR appearance of superficial lesions in type 1 neurofibromatosis is a diffuse, poorly defined focus of heterogeneous signal intensity on T2-weighted images.

Page 1291

The subcutaneous form is always seen in children and bears a close histologic resemblance to a rheumatoid nodule.

Page 1291

Pigmented skin tumors are one of the most frequent reasons for dermatologic evaluation. MR imaging may be useful for differentiating melanoma from benign pigmented skin tumors such as blue nevi and intradermal nevi.

Page 1298

Cutaneous metastases are often harbingers of advanced disease. The distribution of cutaneous metastases roughly parallels the overall incidence of visceral malignancies in the general population.