Plain Radiography, Angiography, and Computed Tomography

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3

Contents

3.1 Introduction

The imaging evaluation of a patient with a suspected soft tissue tumor requires a methodical approach that recognizes the benefits and limitations of the numerous imaging techniques that are available today. Consideration must be given to the financial costs and invasiveness of each technique balanced against the diagnostic reward. The temptation to routinely employ every technique in all patients should be resisted. Similarly, no examination should be reported in isolation without knowledge of relevant clinical details and results of prior investigations. Where possible, the prior investigations themselves should be available for review, as the appreciation of the significance of a new observation may well depend on a retrospective review of the previous studies [20].

In this chapter we discuss the role of plain radiography, angiography, and computed tomography (CT) in the management of a patient with a soft tissue mass, from detection and diagnosis through to the ultimate aim of medical management, a cure. It is beyond the scope of this book to discuss in detail the technology behind each technique. The reader is referred to subsequent chapters for an in-depth discussion of each type of soft tissue tumor.

3.2 Plain Radiography

Despite the undoubted technological advances in imaging over the past two decades, the evaluation of a suspected soft tissue mass should always commence with the plain radiograph [19]. It is cheap, universally available, and easy to obtain. The importance of this single piece of advice cannot be overemphasized. It is stated in virtually every textbook on the subject, but is all too frequently overlooked in day-to-day practice. Indeed it denigrates its value to call it "plain" radiography. In most cases two views at right angles are mandatory to delineate soft tissue planes and the integrity of adjacent cortical bone.

The lack of contrast resolution is a well-recognized limitation of plain radiography, but the value of the examination should not be underestimated. It may not identify the precise diagnosis in any but a minority of cases, but can still provide valuable information, e.g., the presence of calcification and bone involvement. Too often the humble radiograph is denigrated as noncontributory because it has failed to identify features that might be termed "positive." The absence of said features, however, can be just as significant. The absence, for example, of any bony abnormality immediately indicates that the primary pathology is of soft tissue origin, with a large differential diagnosis. Myositis ossificans, as a more specific example, can be effectively excluded from the differential diagnosis of a mass if there is no radiographic evidence of calcification, in all but the earliest of cases. The radiographic features that should be assessed in each case are discussed below [36].

3.2.1 Location

The identification of the location of a tumor is primarily clinical and will dictate which area is initially imaged. Whilst almost all true soft tissue tumors can occur anywhere in the musculoskeletal system, some have a predilection for certain areas, which will be highlighted in later chapters. Many non-neoplastic processes presenting with a soft tissue mass arise at characteristic locations; for example, gouty tophi in the hands and feet, and synovial cysts in the popliteal fossa [22]. Multiple soft tissue masses should suggest neurofibromatosis, lipoma, and occasionally metastatic deposits and Kaposi sarcoma [24, 25, 36]. The vast majority of soft tissue sarcomas, if given the opportunity to metastasize, will do so first to the lungs. It is for this reason that a chest radiograph is a mandatory early investigation in all cases of suspected soft tissue malignancy.

3.2.2 Size

Although the size of a soft tissue mass can have a bearing on subsequent management, the actual size is of limited diagnostic value [24]. Malignant lesions tend to be larger than benign ones [29], but this is rarely helpful in individual cases. Soft tissue masses, irrespective of their tissue of origin, arising in small anatomical areas such as the hands and feet typically are found relatively early. They therefore tend to be smaller than those arising in large anatomical areas such as the buttocks. It can be anticipated that tumors will be larger at presentation in those countries where access to medical facilities remains poorly developed.

3.2.3 Rate of Growth

Alterations in the size of a soft tissue tumor can be crudely estimated clinically and by comparing serial radiographs. Procrastination in advocating follow-up with serial radiographs should only be employed when the clinical and imaging features indicate a benign lesion with a considerable degree of certainty. Failure to promptly diagnose and treat a soft tissue sarcoma can only prejudice the outcome for the patient. Absent or slow growth is typical of a benign neoplasm, whereas malignant tumors frequently show a rapid rate of growth. It should be noted, however, that hemorrhage and infection will also produce rapidly enlarging soft tissue masses.

3.2.4 Shape and Margins

As with the size of a soft tissue tumor, the shape reveals little diagnostic information [36]. Malignant lesions are more commonly irregularly shaped, distorting and obscuring tissue planes. Benign lesions will tend to displace but not obliterate normal tissue planes [25]. Once again, infective lesions can mimic malignancy, as they are also frequently poorly defined due to fluid infiltration of the adjacent soft tissues. The definition of the margins of a lesion depends on a number of factors. These include the anatomical location relative to normal fat planes and bones, and the radiodensity of the constituents of the tumor relative to normal muscle.

3.2.5 Radiodensity

The muscle compartments of the extremities can be visualized radiographically as separated by low-density fat planes. The majority of soft tissues tumors are of a density similar to that of muscle and are, therefore, only revealed by virtue of mass effect. This includes displacement or disruption of the adjacent fat planes (Fig. 3.1), distortion of the skin contour, and involvement of bone.

In a minority of cases, part or all of the tumor may exhibit a radiodensity sufficiently different to that of water for the tumor to be visualized directly. Only fat and gas will give a radiodensity less than that of muscle. Lipomas, the commonest of all the soft tissue tumors, produce a low radiodensity between that of muscle and air. For this reason lipomas are well demarcated from the surrounding soft tissues and can be diagnosed with moderate confidence [17, 25] (Fig. 3.2). It should be noted that low-grade liposarcomas may contain variable amounts of lipomatous tissue, which also appears relatively radiolucent on radiography (Fig. 3.3). A low-kilovoltage technique can be used to accentuate the density differences between fat and muscle [25, 26, 33].

Air in the soft tissues is said to be specific to infection [24]. While infection is certainly the commonest cause, it may also be seen in necrotic fungating tumors, albeit with secondary infection (Fig. 3.4), as well as being a normal feature following open biopsy or other surgical procedures. Air in the soft tissues of the thoracic wall and neck always suggests the possibility of surgical emphysema.

Increased radiodensity may be seen in the tissues due to hemosiderin, calcification, or ossification. Hemosiderin deposition typically occurs in synovial tissues exposed to repeated hemorrhage, such as pigmented villonodular synovitis and hemophiliac arthropathy. Radiographs can distinguish between calcification and ossification and the differing patterns [49]. Mineralization in the soft tissues is a feature of a large spectrum of disorders including congenital, metabolic, endocrine,

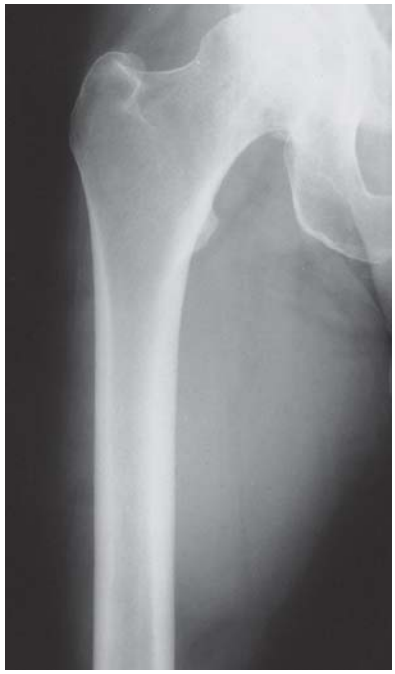


Fig. 3.1. Myxofibrosarcoma arising in the adductors of the upper thigh in a 75-year-old man. Plain radiograph. The tumor is only visible by virtue of its mass effect on tissue planes

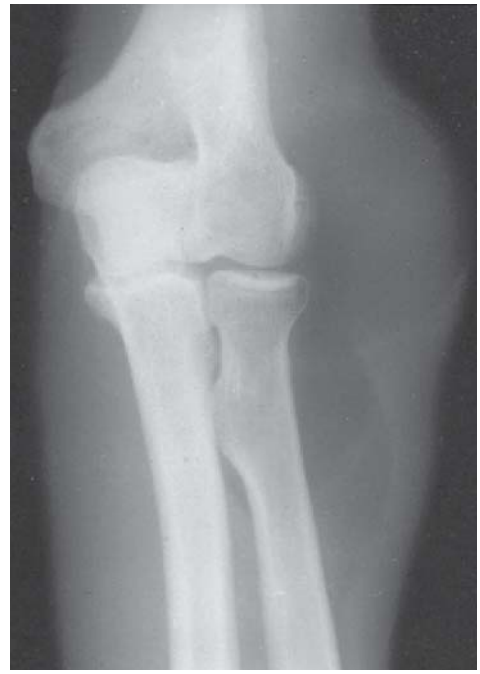
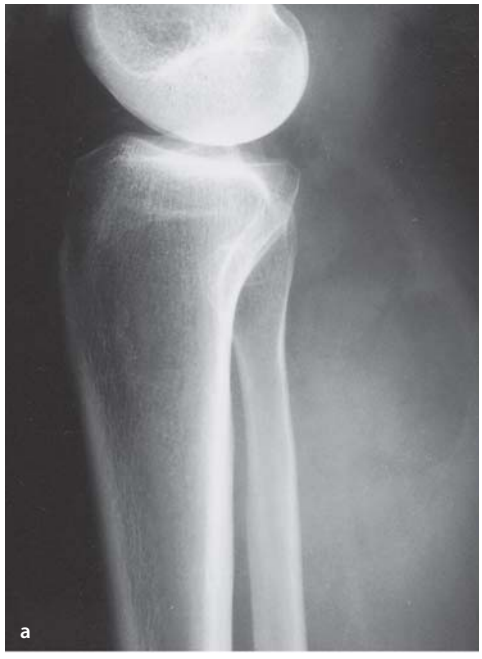


Fig. 3.2. Lipoma arising on the radial aspect of the elbow. Plain radiograph. The tumor is sharply marginated with the uniform low density of fat



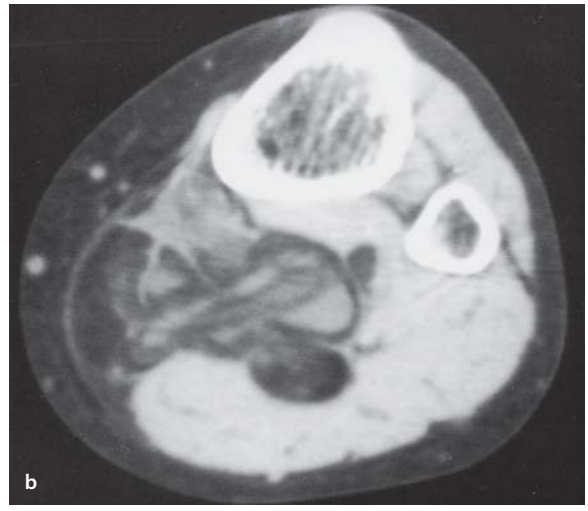


Fig. 3.3 a, b. Low-grade liposarcoma arising behind the knee joint in a 55-year-old woman. **a** Plain radiograph. **b** Computed tomography (CT). Fat density areas are visible on the radiograph (**a**) with mixed fat and soft tissue attenuation on CT (**b**)

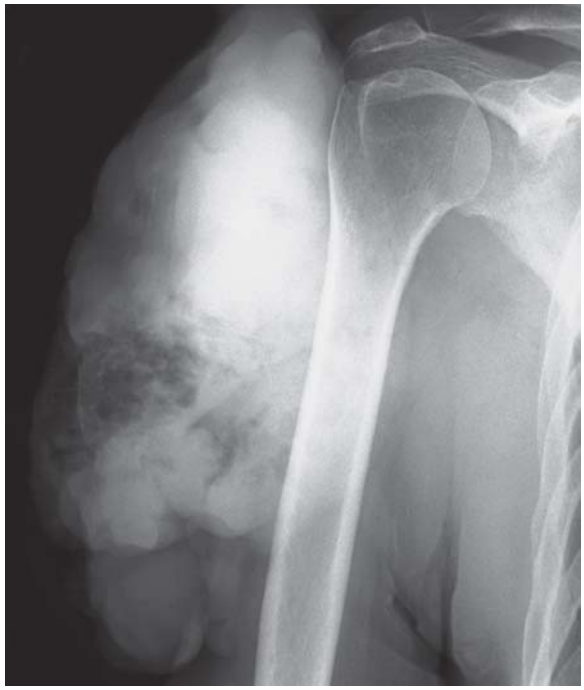


Fig. 3.4. Necrotic, fungating clear cell sarcoma in a 62-year-old woman. Plain radiograph. The loculi of gas within the tumor indicate secondary infection

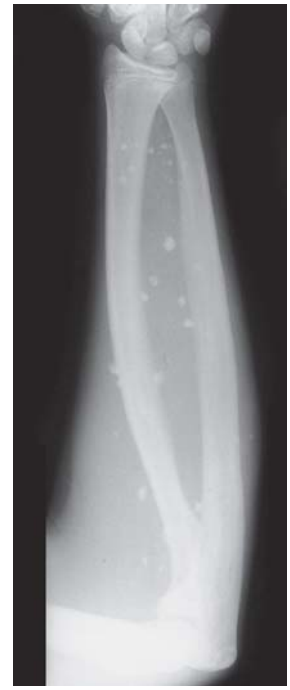


Fig. 3.5. Extensive hemangioma of the forearm in an adolescent male. Plain radiograph. Note the presence of multiple phleboliths

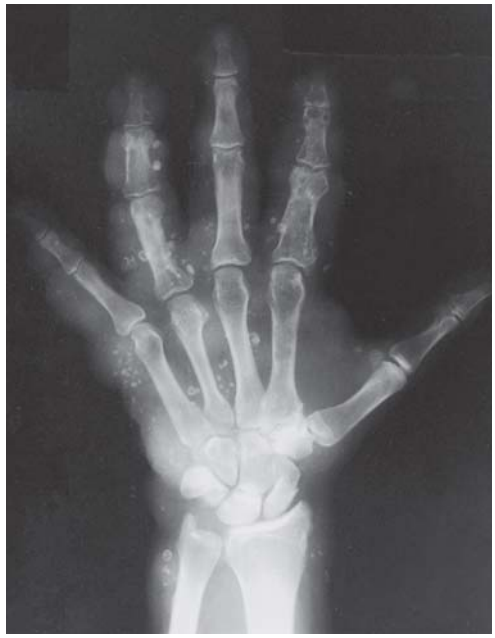


Fig. 3.6. Maffucci syndrome in a 32-year-old man. Plain radiograph. Multiple enchondromas and soft tissue hemangiomas indicated by the phleboliths

traumatic, and parasitic infections [35]. Primary soft tissue tumors are one of the less common causes of calcification that the general radiologist can expect to see in his or her routine practice. Close attention to the clinical details and location will exclude many of the non-neoplastic causes. For example, soft tissue calcifications in the hands and feet are rarely associated with neoplasia, and many of the multifocal lesions will be either due to a collagen vascular disorder or the residuum of a parasitic infection. Again, the clinical details and country of origin of the patient should be pointers to the correct diagnosis. Occasionally certain normal variants, including companion shadows and the fascia lata, may simulate soft tissue calcification or periosteal new bone formation and should not be mistaken for a neoplastic process [18].

Analysis of the pattern of calcification within a soft tissue tumor can indicate the tissue type. Circular foci with a lucent center representing a phlebolith, when identified outside the pelvis, is diagnostic of a hemangioma (Fig. 3.5). Phleboliths are not usually apparent until adolescence, so that conditions such as Maffucci syndrome (Fig. 3.6) in the child may not be radiographically distinguishable from multiple enchondromatosis (Ollier disease).

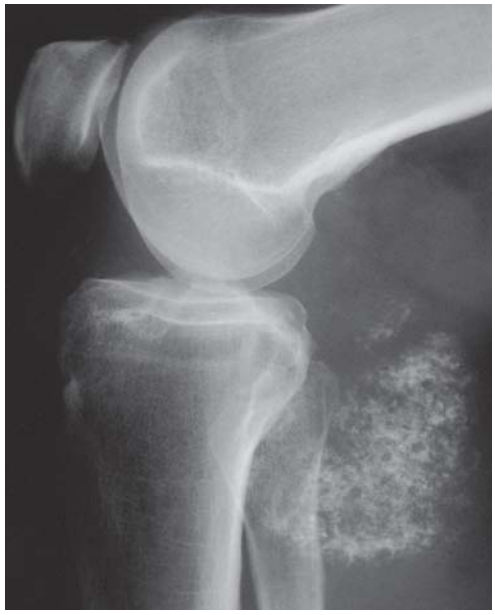


Fig. 3.7. Soft tissue mass in a 62-year-old man. Plain radiograph. Characteristic chondroid calcifications arising from the posterior aspect of the knee joint due to synovial chondromatosis

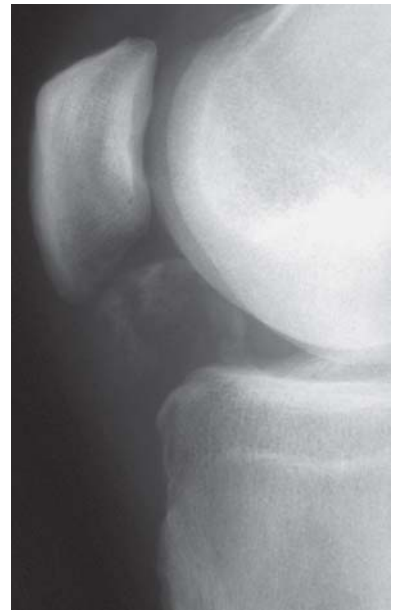
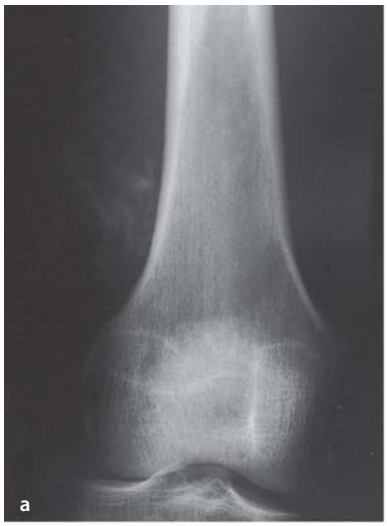


Fig. 3.8. Para-articular osteochondroma in a 44-year-old man. Plain radiograph. Minor ossification arising in the Hoffa fat pad



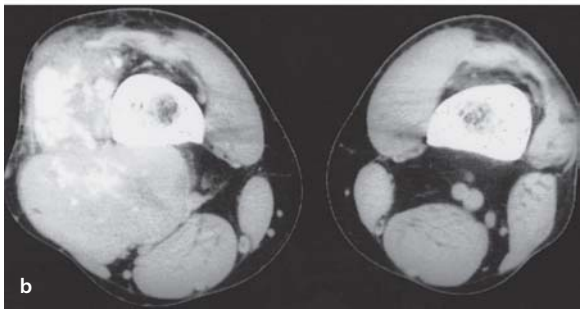


Fig. 3.9 a, b. Synovial sarcoma arising in the vastus lateralis in a 66-year-old man. **a** Plain radiograph. **b** CT. Both imaging techniques demonstrate amorphous calcification

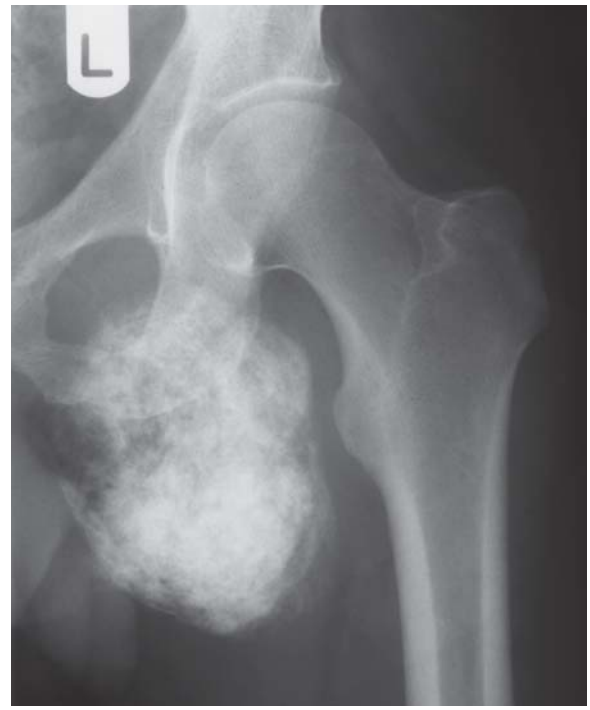


Fig. 3.10. Extraskeletal osteosarcoma in a 50-year-old man. Plain radiograph. Densely mineralized lesion arising in the adductors

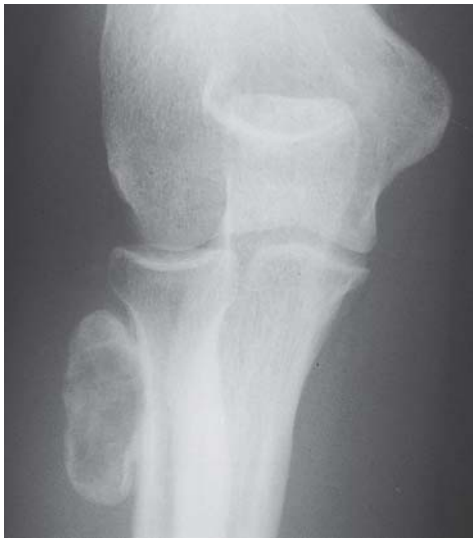


Fig. 3.11. Myositis ossificans of the forearm in a 38-year-old woman. Plain radiograph. Soft tissue mass lying on the surface of the proximal radius showing typical peripheral mineralization

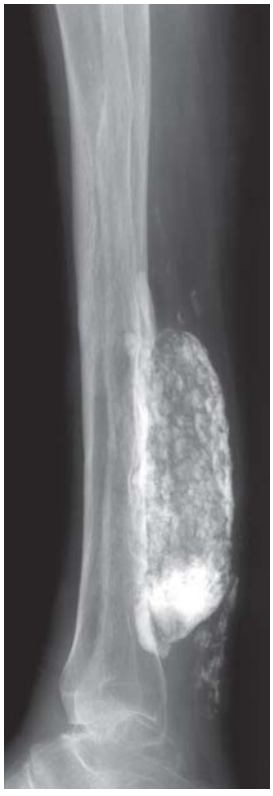


Fig. 3.12. Calcific myonecrosis in an 87-year-old woman. Plain radiograph. Soft tissue mass with peripheral mineralization causing pressure erosion on the adjacent tibia

Chondroid tissue reveals ring-and-arc calcification. While this does not distinguish between benign or malignant cartilage formation, the majority of soft tissue masses with this feature, in the vicinity of a joint, will arise from synovial chondromatosis [34] (Fig. 3.7), and in the hands and feet will be soft tissue chondromas. Calcification or ossification in the infrapatellar (Hoffa) fat pad is typical of a para-articular chondroma/osteochondroma (Fig. 3.8) [13].

Osteoid mineralization may occur as "cloud-like" densities or mature trabecular bone. The latter suggests a slow-growing lesion such as a lipoma, low-grade liposarcoma, or hemangioma [24]. Poorly defined, amorphous calcification is found in up to 30% of synovial sarcomas (Fig. 3.9) [4, 14, 27] and approximately 50% of extraskeletal osteosarcomas (Fig. 3.10). This is an extremely useful distinguishing feature from the tumor mimic myositis ossificans, which exhibits marginal calcification (Fig. 3.11) [9, 30]. Another traumatic condition that presents with a peripherally mineralized mass, almost exclusively in the calf, many years after a major injury, is calcific myonecrosis (Fig. 3.12) [7].

3.2.6 Bone Involvement

It may be difficult to differentiate a primary soft tissue tumor with osseous involvement from a bone tumor with soft tissue extension [24, 25]. As a rule, the site of the more extensive abnormality, be it bone or soft tissue, represents the primary focus [36]. Only a minority of soft tissue tumors involve bone. The degree of bone involvement may vary from cortical hyperostosis, as seen in a parosteal lipoma (Fig. 3.13), through the pressure erosion seen in slow-growing masses (Fig. 3.14), to direct invasion, as seen in aggressive lesions (Fig. 3.15). The presence of ill-defined cortical destruction is strongly indicative of malignancy, although it may also occur with paraosseous infections. The converse does not apply in that well-defined pressure erosion may occur with both benign and malignant soft tissue tumors (Fig. 3.11). Aggressive fibromatosis (extra-abdominal desmoid tumor) is a benign, but locally invasive condition which can cause irregular adjacent bone erosion in one-third of cases (Fig. 3.16).

Cortical destruction with an outer, saucer-like configuration, "saucerization," occurs in Ewing's sarcoma and bony metastatic disease and should not be mistaken for secondary bone invasion from a large soft tissue sarcoma [21].

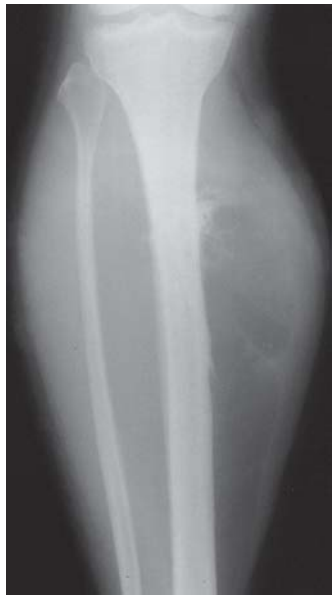


Fig. 3.13. Parosteal lipoma arising on the surface of the tibia in a 67-year-old woman. Plain radiograph. Lobulated fat density mass with typical periosteal new bone formation

Fig. 3.14. Myxofibrosarcoma of the upper leg in a 65-year-old man. Plain radiograph. Soft tissue mass causing pressure erosion on the medial cortex of the femoral diaphysis

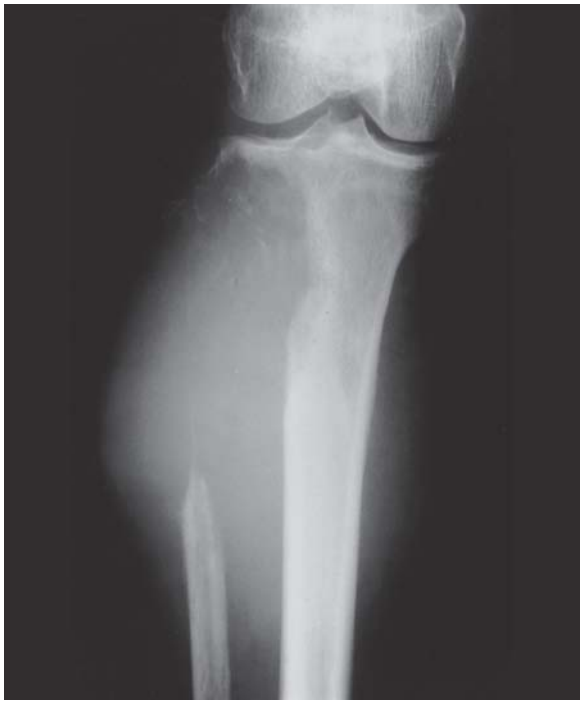


Fig. 3.15. Spindle cell sarcoma of the calf in a 78-year-old woman who refused medical treatment for 2 years. Plain radiograph. The tumor has destroyed the proximal fibula, with extensive invasion of the tibial metaphysis

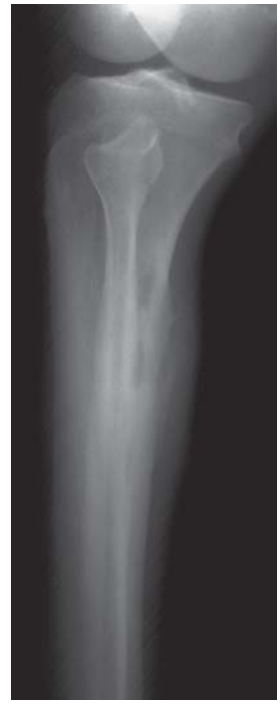


Fig. 3.16. Aggressive fibromatosis in a 37-year-old woman. Plain radiograph. There is erosion of the proximal tibia

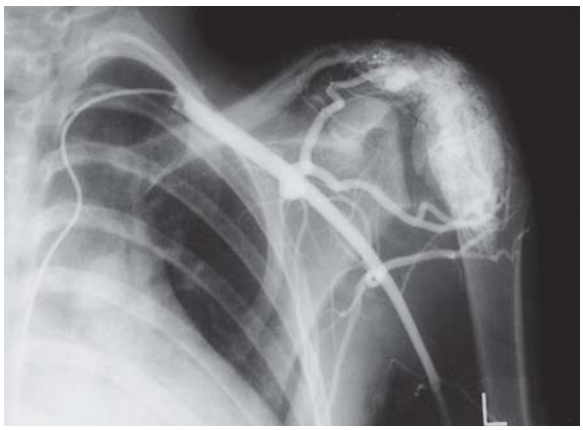


Fig. 3.17. Cavernous hemangioma of the soft tissues over the shoulder in an adolescent male. Angiography. An early film from a selective subclavian angiogram shows feeding via the thoracoacromial and circumflex humeral arteries

3.3 Angiography

Prior to the introduction of cross-sectional imaging, angiography was the most useful imaging technique for the demonstration of soft tissue sarcomas. For many years it was considered an important adjunct to conventional radiography in patient management [15, 23]. The angiographic features of soft tissue malignancies are similar to those at other sites [10]: tumor stain/blush, vessel encasement, and early venous filling. There is an association between increasing vascularity of a tumor and the degree of malignancy [2]. Despite this, it can be difficult to differentiate benign from malignant soft tissue tumors by angiography [15, 16, 44]. Inflammatory lesions such as myositis ossificans appear hypervascular, thereby being easily mistaken for malignancy [50]. Angiography currently has little role in the diagnosis and staging of most soft tissue tumors.

Decreased vascularity is considered a good indicator of tumor response to therapy [10]. It is difficult to justify angiography for this purpose because of its cost and invasiveness. Digital vascular imaging has improved image quality and reduced the radiation dose and contrast-medium load to the patient, but has not fundamentally altered the role of angiography in this patient group.

Angiography can delineate the full extent of feeding and draining vessels of vascular malformations, but has been largely superseded by CT angiography or magnetic resonance (MR) angiography. Preoperative angiography may continue to be employed in planning surgery in difficult cases or as a prelude to embolotherapy [47, 51].

Angiography can differentiate between the two histological types of hemangioma, capillary and cavernous (Fig. 3.17). MR angiography can be a useful adjunct to MRI in selected cases. This includes the differentiation of a soft tissue tumor from an aneurysm.

Controversy exists as to whether the use of adjuvant chemotherapy significantly improves the prognosis for most patients with a high-grade soft tissue sarcoma. In some of the treatment centers in which chemotherapy is given to patients, an intra-arterial route is advocated. In this situation prior angiography is required to ensure optimal siting of the catheter through which the chemotherapy will be administered.

3.4 Computed Tomography

The introduction of CT proved a revolution in the detection and preoperative management of soft tissue tumors [12, 15, 23, 41]. For the first time, a degree of precision was applied to preoperative staging that had previously not been possible. The improving spatial resolution of CT allows for tumors as small as 1–2 cm to be detected, depending on differential attenuation between the tumor and the surrounding soft tissues. The superior contrast sensitivity and cross-sectional ability of CT will reveal masses that are not visible on conventional radiography. Conversely, the demonstration of normal anatomy will exclude all but the smallest lesions.

3.4.1 Technical Considerations

Attention to technique is important. Contiguous slices should be obtained, no more than 5 mm thick. If an interslice gap is employed, there is the potential for understaging involvement of the neurovascular structures, as part of the tumor will not be imaged. Of equal importance are the cranial and caudal margins, which should be clearly demonstrated. In the lower limbs, both sides should be included in the scan field to allow comparison of the normal and abnormal anatomy. In this way subtle abnormalities may be more easily detected. This is not possible with the upper limbs because of the loss of resolution resulting from a scan field that is adequate to include the thorax and both upper limbs. Beam-hardening artifacts can be a particular problem in the upper limb and can be minimized by raising the unaffected arm above the head when positioning the patient on the examination couch.

The images should be assessed using both bone and soft tissue window settings. The window levels utilized will depend on personal preference and the type of scanner. Narrow window settings will be required if density differences are small. The full craniocaudal extent of the tumor can be displayed by performing sagittal or coronal reconstructions. The slice thickness used impacts on reconstruction resolution. The

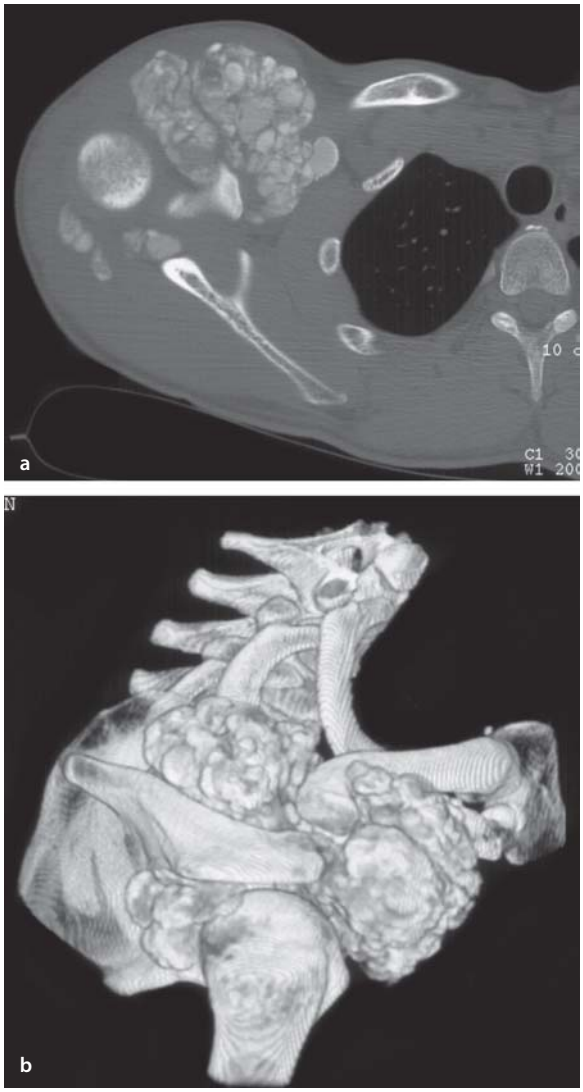


Fig. 3.18 a, b. Tumoral calcinosis associated with chronic renal failure. **a** Computed tomography. **b** Surface-rendered 3D reconstruction. Soft tissue masses with amorphous calcification. The distribution is readily appreciated on the reconstruction (**b**)

introduction in the last 10 years of multislice CT or multidetector-row CT has lead to a renaissance in this technique. Very fast image-acquisition times of large volumes with submillimeter section thickness have become the norm. Although there are some concerns regarding the potential for increasing the radiation dose, thin-section scanning allows for different types of postprocessing, such a multiplanar reconstructions, volume rendering, and surface-shaded display (Fig. 3.18) [38].

3.4.2 CT Features

The CT features that should be assessed in each case are similar to those described above for evaluating the conventional radiograph. This reflects the fact that both are radiographic techniques relying on the attenuation of an X-ray source. The principal advantages of CT over the radiograph are the improved soft tissue resolution and the axial, in contrast to longitudinal, imaging plane. The first feature to assess is the attenuation value of the mass. Fat will show the lowest attenuation of any tissue, and a benign lipoma can be diagnosed on CT by the uniformly low attenuation (–70 to –130 HU; Fig. 3.19) [11, 17]. It is not possible to reliably differentiate on CT a simple lipoma from an atypical lipoma (well-differentiated liposarcoma). In the peripheries this is rarely a management problem, as the treatment of the two conditions is the same. A few fibromuscular septa of soft tissue density traversing the lipoma are acceptable (Fig. 3.19). A tumor comprising a combination of fat and solid component is suggestive of a low-grade liposarcoma (Fig. 3.3b) [6]. Only air will show an attenuation less that that of fat (Fig. 3.20).

Fluid-filled structures, seromas, old hematomas, and synovial cysts have an attenuation value less than that of muscle and more than that of fat (Fig. 3.21) [39, 40, 43]. Such fluid collections are usually homogeneous and well-defined. Abscesses typically have an attenuation value slightly higher than that of simple fluid (Fig. 3.20) [32, 48].

The majority of soft tissue sarcomas have an attenuation value slightly less than that of normal muscle (Fig. 3.22). The highest attenuation found in the soft tissues on CT is that of calcification and ossification, approximating to that of cortical bone. CT exquisitely demonstrates calcification more clearly than conventional radiography (Figs. 3.9, 3.23) and can easily distinguish between calcification and ossification (Figs. 3.9, 3.24) [49]. A peripheral ring of calcification is a characteristic CT feature of myositis ossificans (Fig. 3.25) [1, 19]. The differential diagnosis should include the rare soft tissue aneurysmal bone cyst which also shows peripheral calcification [45].

Tumor margins can easily be defined on CT in most cases provided there is sufficient mass effect or attenuation difference. As might be expected, slow-growing lesions tend to be better defined than aggressive lesions. The margin is an indicator of the rate of growth rather than whether it is benign or malignant. As on conventional radiographs, infective lesions will tend to be poorly defined due to fluid infiltration in the surrounding soft tissues (Fig. 3.20) [32, 48]. The conspicuity of tumor margins and the relationship to adjacent vessels can be improved following enhancement with iodinated contrast medium (Fig. 3.22) [46]. Contrast medium is helpful in those cases where there is doubt as to whether

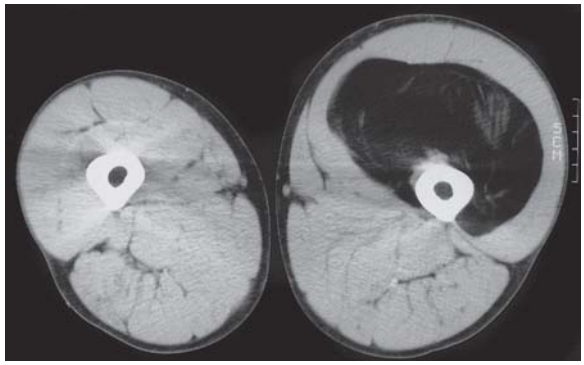


Fig. 3.19. Benign lipoma in the left anterior thigh of a 26-year-old man. Using computed tomography, a few fibromuscular septa can be identified traversing the lipoma

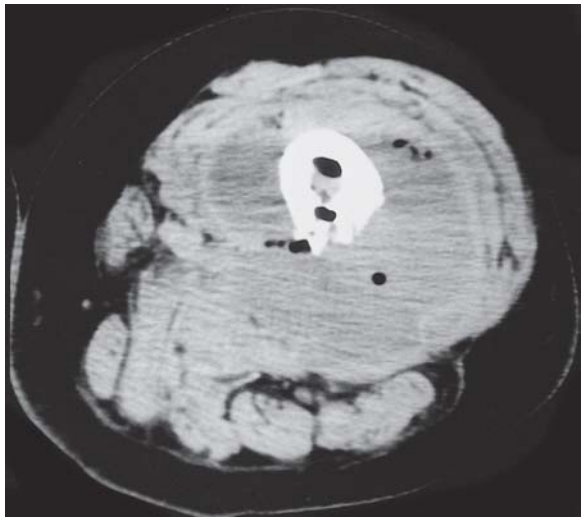


Fig. 3.20. Gas-forming clostridial osteomyelitis of the femur in a 59-year-old man. Computed tomography. Loculi of gas are present within the bone and surrounding abscess

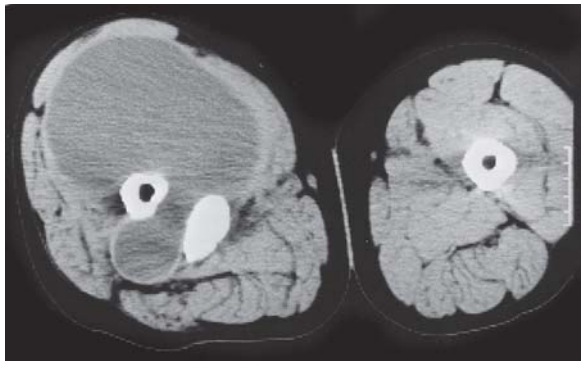
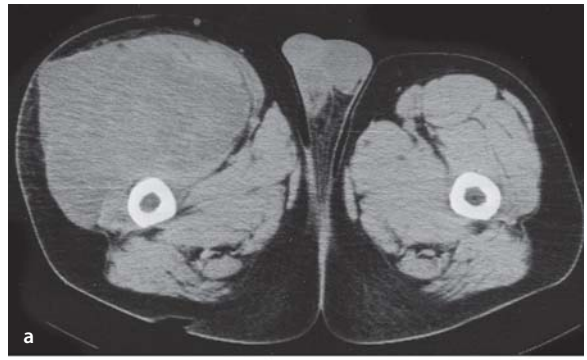


Fig. 3.21. Chronic hematoma in the thigh of a 28-year-old man at the site of nonunion of an old femoral fracture. Computed tomography. The overlapping fracture ends are seen as two separate bony structures. The attenuation of the hematoma measures 20 HU surrounded by a higher attenuation pseudocapsule



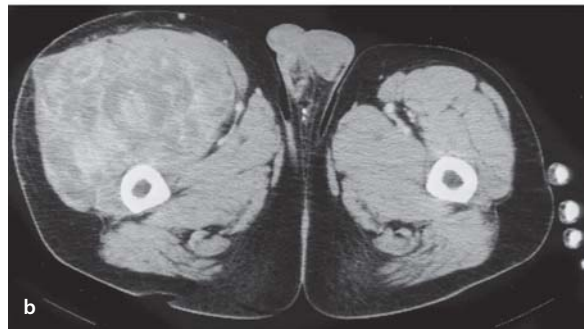


Fig. 3.22 a, b. Liposarcoma of the thigh in a 68-year-old man. **a** Computed tomography (CT) scan. **b** After intravenous contrast medium. Mass arising in the right vastus intermedius muscle slightly hypodense to muscle on unenhanced CT (**a**) and irregularly enhancing after contrast administration (**b**)

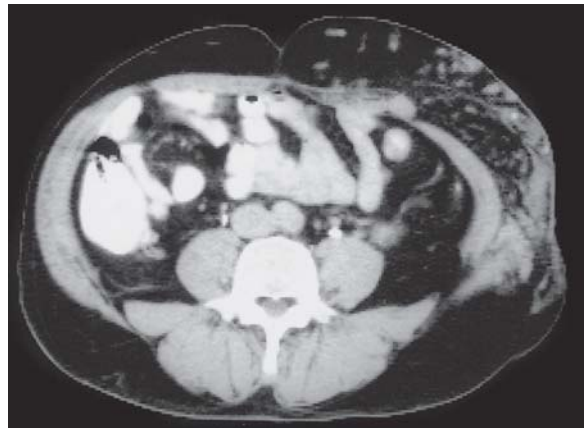


Fig. 3.23. Arteriovenous malformation of the abdominal wall in a 28-year-old woman. Computed tomography. Tiny phleboliths within the subcutaneous tissues of the anterior abdominal wall, not visible on plain radiography, help to confirm the diagnosis

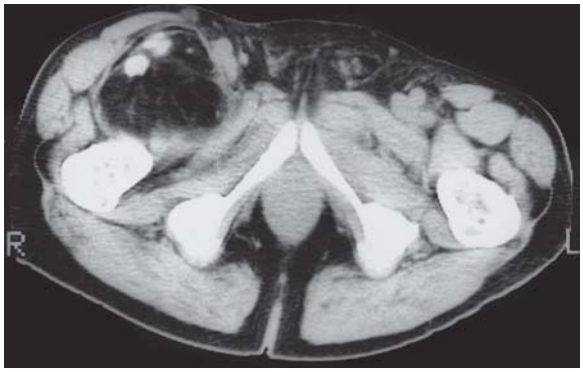


Fig. 3.24. Lipoma of the right thigh in a 51-year-old man. Computed tomography. Hypodense mass arising in the right adductor compartment containing fibromuscular septa and several foci of ossification

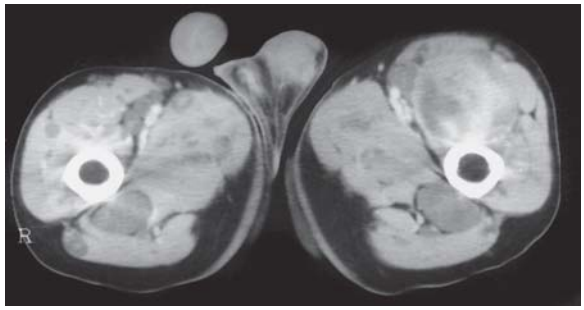


Fig. 3.26. Neurofibromatosis in the proximal thighs of a 23-year-old man. Computed tomography (CT) after iodinated contrast injection. Enhancement of the neurofibrosarcoma in the left anterior thigh. The numerous remaining neurofibromata, particularly involving the sciatic nerves, show no significant enhancement

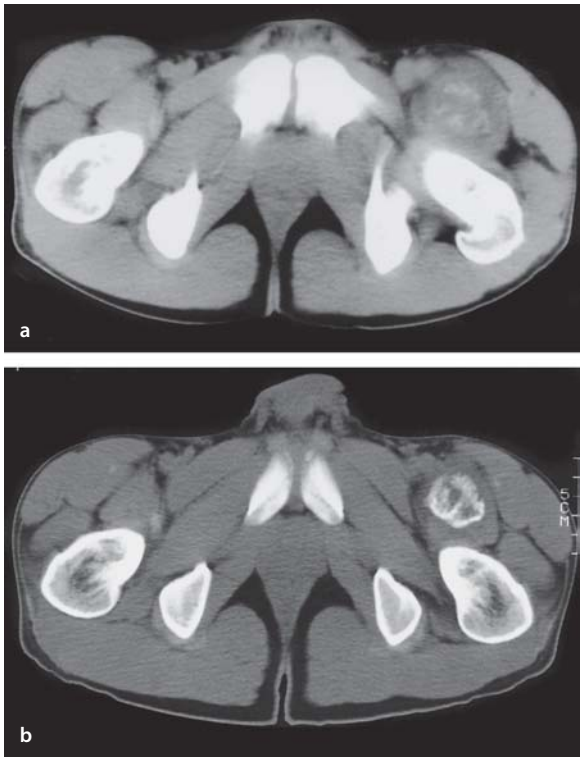


Fig. 3.25 a, b. Myositis ossificans of the proximal thigh in a 12-year-old girl. **a** Computed tomography (CT). **b** CT 6 weeks later. Mass with early peripheral calcification in the left iliopsoas muscle (**a**) and the signs of maturation 6 weeks later (**b**)

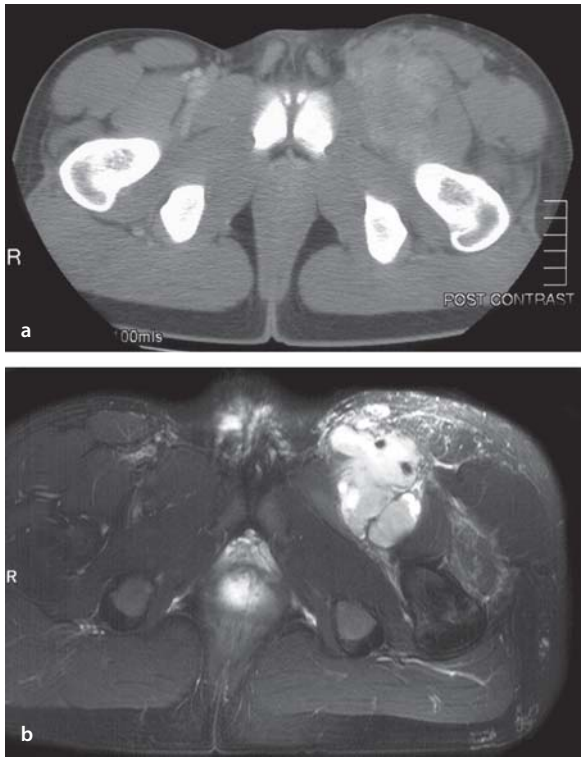


Fig. 3.27 a, b. Synovial sarcoma in a 19-year-old man. **a** Computed tomography (CT) with intravenous contrast medium. **b** Axial T2-weighted, fast spin-echo image with fat suppression. Both show the tumor arising in the left groin with involvement of the femoral vessels, but the features are more conspicuous on the MR image (**b**)

a mass is solid or cystic. Very occasionally a soft tissue tumor will be isodense with muscle on a precontrast CT scan and only be revealed on a postcontrast examination [23]. In this situation, the presence of mass effect will usually be sufficient to alert the wary observer. Contrast enhancement will also give an indication of the vascularity of a tumor, which can be of value in selected cases (Figs. 3.26, 3.27).

CT gives an excellent demonstration of the relationship of a soft tissue tumor to the adjacent bones. It is more accurate than conventional radiography, but less so than MRI, revealing medullary bone involvement. It can be useful in assessing the relationship of a tumor to bone in anatomically complex areas such as the spine and pelvis.

3.4.3 CT Compared with MRI

Studies have suggested that CT tends to overestimate the extent of a soft tissue sarcoma [8, 28], presumably due to local lymphatic obstruction. This is not a problem for management, as curative surgery will require excision of the whole compartment, edema and all. It would be a matter of more concern were CT to underestimate the true tumor extent, as this would prejudice attempts at curative surgery.

With limb-salvage surgery, the aim in most patients, there is always a risk of local recurrence, particularly in patients with a high-grade sarcoma. The risk is increased considerably if the excision is found to be marginal or even intralesional. MRI is the preferred technique to detect early recurrences, but both techniques are of comparable accuracy if the recurrence is greater than 15 cm^3 in volume [37]. CT is unable to reliably differentiate residual tumor from hematoma and granulation tissue following excisional biopsy [16].

Twenty years ago it was being claimed that MRI would supersede CT as the primary imaging technique in the evaluation of soft tissue tumors [3, 5]. In the developed world, this prediction has been fulfilled, but where access to MRI remains limited or contraindicated, CT will continue to provide an adequate alternative for the majority of patients with a soft tissue mass. Indeed, one study comparing CT and MRI in the local staging of primary malignant musculoskeletal neoplasms yields the conclusion that both techniques are equally accurate in the local staging of bone and soft tissue neoplasms (Fig. 3.27) [31]. In fairness, this study has been the subject of some controversy since its publication, as critics argue that many of the MR examinations were obtained on older machines, without the use of an intravenous gadolinium chelate [42].

CT remains preeminent in the investigation of chest metastases, revealing nodules several millimeters in diameter that are not visible on a chest radiograph. A CT examination of the chest should be performed as part of the initial preoperative staging of patients with a soft tissue sarcoma. Multislice CT, by eliminating respiratory motion and minimizing partial volume errors, results in a high rate of detection of smaller nodules than are detected with conventional CT. Routine follow-up of patients with serial chest CT examinations is of doubtful value, particularly in view of the considerable radiation dose involved. CT of the chest is indicated if a follow-up chest radiograph suggests early metastatic disease. Metastatic spread to regional lymph nodes is uncommon in soft tissue sarcomas and is usually present only in the later stages of the disease. CT identifies abnormally enlarged nodes but cannot reliably distinguish reactive change from metastatic involvement.

CT can be used to facilitate biopsy of soft tissue tumors, particularly utilizing CT fluoroscopy [52]. It is usually reserved for those cases in which tumors are either small (i.e., impalpable) or situated in a relatively inaccessible location.

Things to remember:

1. Evaluation of a suspected soft tissue mass should always commence with plain radiography. Valuable information may be derived from the presence of calcifications or ossifications, internal fatty components, and air and bone involvement.
2. Angiography has been largely replaced by MRI for soft tissue tumor characterization. It may still be used to preclude embolotherapy or in the case of isolated-limb perfusion with chemotherapy.
3. CT has been superseded by MRI for soft tissue tumor characterization, but it remains valuable for guiding biopsy and for the detection of distant tumor spread in the lungs.

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