

## American College of Radiology ACR Appropriateness Criteria®

**Clinical Condition:** Soft-Tissue Masses

**Variant 1:** Clinically suspected soft-tissue mass: general.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray area of interest	9	Radiographs may not preclude the need for advanced imaging.	NS
MRI area of interest with or without contrast	9	Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under "Anticipated Exceptions."	O
US area of interest	5	Useful to differentiate solid from cystic mass. With Doppler as needed. With appropriate expertise.	O
CT area of interest with or without contrast	4	Use of contrast depends on clinical situation and radiologist discretion.	NS
Tc-99m bone scan area of interest	1		☢ ☢ ☢
FDG-PET area of interest	1		☢ ☢ ☢ ☢
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 2:** Mass palpated at a joint.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray area of interest	9	Useful for evaluation of underlying arthropathy. May not preclude the need for advanced imaging.	NS
MRI area of interest with or without contrast	9	Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under "Anticipated Exceptions."	O
US area of interest	7	With Doppler as needed. With appropriate expertise.	O
CT area of interest with or without contrast	3	Use of contrast depends on clinical situation and radiologist discretion.	NS
X-ray arthrography area of interest	3	Can be useful to document communication with joint if indeterminate by MRI or US.	NS
Tc-99m bone scan area of interest	1		☢ ☢ ☢
FDG-PET area of interest	1		☢ ☢ ☢ ☢
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:****Soft-tissue Masses****Variant 3:****Soft-tissue mass: foot.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
X-ray foot	9	Radiographs have lower value in soft-tissue masses in the foot. Radiographs may not preclude the need for advanced imaging.	Min
MRI foot with or without contrast	9	Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under "Anticipated Exceptions."	O
US foot	6	Can be very useful, especially for Morton's neuroma. With Doppler as needed. With appropriate expertise.	O
CT foot with or without contrast	3	Use of contrast depends on clinical situation and radiologist discretion.	Min
Tc-99m bone scan foot	1		☼ ☼ ☼
FDG-PET foot	1		☼ ☼ ☼ ☼
<b>Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

**Variant 4:****Soft-tissue mass: abdominal or chest wall.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
X-ray abdomen	9	Radiographs may not preclude the need for advanced imaging.	☼ ☼ ☼
X-ray chest	9	Radiographs may not preclude the need for advanced imaging.	Min
CT abdomen or chest with or without contrast	9	Use of contrast depends on clinical situation and radiologist discretion.	☼ ☼ ☼
MRI abdomen or chest with or without contrast	7	Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under "Anticipated Exceptions."	O
US abdomen or chest	3		O
Tc-99m bone scan abdomen or chest	1		☼ ☼ ☼
FDG-PET abdomen or chest	1		☼ ☼ ☼ ☼
<b>Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

**Clinical Condition:****Soft-tissue Masses****Variant 5:****Calcified soft-tissue mass not definitely benign seen on radiographs.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
MRI area of interest with or without contrast	9	Use of MRI vs CT depends on clinical scenario and lesion location. Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under “Anticipated Exceptions.”	O
CT area of interest with or without contrast	9	Use of MRI vs CT depends on clinical scenario and lesion location. Use of contrast depends on clinical situation and radiologist discretion.	NS
US area of interest	3		O
Tc-99m bone scan area of interest	1		☼ ☼ ☼
FDG-PET area of interest	1		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 6:****Negative or nonspecific findings on radiographs in area of palpated mass.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
MRI area of interest with or without contrast	9	Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under “Anticipated Exceptions.”	O
US area of interest	5	With Doppler as needed. With appropriate expertise.	O
CT area of interest with or without contrast	5	Use of contrast depends on clinical situation and radiologist discretion.	NS
Tc-99m bone scan area of interest	1		☼ ☼ ☼
FDG-PET area of interest	1		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 7:****Follow-up of spontaneous soft-tissue hemorrhage in older adult.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
MRI area of interest with or without contrast	9	Use of contrast depends on clinical situation and radiologist discretion. See statement regarding contrast in text under “Anticipated Exceptions.”	O
CT area of interest with or without contrast	7	Use of contrast depends on clinical situation and radiologist discretion.	NS
US area of interest	5	With Doppler as needed. With appropriate expertise.	O
X-ray area of interest	3		NS
Tc-99m bone scan area of interest	1		☼ ☼ ☼
FDG-PET area of interest	1		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

## SOFT-TISSUE MASSES

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### **Summary of Literature Review**

Imaging may be requested for patients with suspected soft-tissue masses because of a painful or painless soft-tissue abnormality palpated by the patient or physician or because of symptoms such as pain or other complaints with no detectable mass on physical examination. The type of imaging technique initially selected varies depending on the history and physical findings as well as the suspected location of the mass. It is well known that biopsy of a presumed soft-tissue mass without an imaging workup is inadvisable.

There has been tremendous progress in imaging evaluation of soft-tissue masses over the years. With the advent of magnetic resonance imaging (MRI), lesion detection, differentiation of normal anatomic variants from true lesions, and characterization of lesions have improved because of its superior soft-tissue contrast and multiple-image plane capabilities [1-4]. Computed tomography (CT) and ultrasound (US) can be useful for problem solving by helping to characterize the nature of soft-tissue masses [2,5,6]. Also note that some lesions arising from bone (ie, osteochondroma or the soft-tissue component of a bone tumor) can present as deep soft-

tissue masses clinically. In this case, radiographs can be useful.

### **Radiography**

Although radiographs are useful in the workup of a soft-tissue mass, they may not obviate the need for more definitive cross-sectional evaluation. Findings on radiographs are generally nonspecific and can even be misleading when interpreted in isolation. Radiographs should be considered as an adjunct examination, providing useful information when interpreted in conjunction with advanced modalities. If there has been clear trauma and subsequently a masslike swelling develops, radiographs can be useful to track development of myositis ossificans; however, MRI may still be needed to evaluate the extent of soft-tissue injury. Also, small soft-tissue sarcomas can hemorrhage and present clinically following regional trauma. In fact, it is prudent to follow “spontaneous hemorrhage” in older patients to avoid missing an underlying sarcoma. Location is another important consideration; for example, in the foot and ankle, radiographs may be of less value since soft-tissue masses there are often related to noncalcified lesions such as plantar fibromas, ganglion cysts, and Morton’s neuromas.

### **Ultrasound**

US is not frequently used for evaluating soft-tissue masses at most institutions. This technique is valuable in differentiating cystic from solid lesions and has also been used to study vascularity of lesions [6-8].

Soft-tissue masses palpated around joints (especially around the knee) often originate from the joint, representing such lesions as ganglion cysts, parameniscal or paralabral cysts, and bursal collections. Radiographs often are noncontributory other than to show underlying osteoarthritis. Obviously, this does not preclude the presence of a sarcoma; the most common soft-tissue malignancies, including malignant fibrous histiocytoma and synovial cell sarcoma, often occur near joints as well, but they do not usually communicate with the joint. Therefore, demonstration of communication with the joint is essential. This can be performed using US or MRI; MRI gives the added benefit of documenting internal derangement that is often the cause of the cyst.

### **Computed Tomography**

Since the introduction of MRI, CT has largely been replaced as the technique of choice for evaluating soft-tissue masses. However, in some cases, CT may still be appropriate for evaluating soft-tissue lesions. Situations such as suspected lipoma, calcification in soft-tissue lesions seen on routine radiographs, or suspected myositis ossificans based on clinical or radiographic data might be better evaluated with CT. Lipomas are easily characterized on both CT and MRI [2,5]. In addition, patient size or the location of a lesion may dictate that CT is the preferred technique. Such locations include the

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abdominal or chest wall, where motion artifact can create suboptimal imaging with MRI [2,9]. A report of the Radiology Diagnostic Oncology Group on 133 soft-tissue tumors suggested that MRI and contrast-enhanced CT are comparable for determining tumor size and involvement of surrounding structures [10]. However, MRI has additional benefits for differential diagnosis of the lesion and preprocedural evaluation.

### **Magnetic Resonance Imaging**

MRI has become the technique of choice for detecting and characterizing soft-tissue masses. Its improved soft-tissue contrast and multiple-image plane capabilities have provided significant advantages for lesion conspicuity, characterization, and determining the extent of involvement [2-4,9,11-13]. Vascular structures can also be more easily identified and evaluated without the need for intravenous contrast agents [2]. Vascular structures and neurovascular involvement are more easily defined in 20% of cases compared with CT [2]. Cortical bone involvement by soft-tissue masses can be identified equally by either CT and MRI [2,4,9,10]. However, the extent of marrow involvement can be difficult to determine by CT, and there is evidence that tumor infiltration can extend beyond the apparent margin of the mass [14].

Though lesions are more easily detected with MRI, its ability to differentiate benign from malignant lesions remains controversial. Numerous studies have evaluated MR imaging features of soft-tissue lesions [1,10,13-22]. Reports discussing correct histologic diagnosis or differentiating benign from malignant lesions describe accuracy ranges from 24%-90%. Though imperfect, the superior soft-tissue contrast provided by T2-weighted MRI reveals features that are useful for characterizing lesions. Malignant lesions are heterogeneous (72%-94%), larger (90% >33 mm), and more frequently involve bone and neurovascular structures [4,9,13]. The pattern of gadolinium enhancement may help identify some lesions as malignant, such as myxoid liposarcoma, and has shown utility in evaluating the aggressiveness of vascular and lipomatous masses [17,18]. Contrast is useful for identifying cystic and necrotic components of soft-tissue masses, helping to characterize lesions and identifying solid areas for biopsy. Dynamic gadolinium enhancement characteristics may be useful, but there is overlap between benign and malignant lesions [19,20]. Advanced MRI techniques such as spectroscopy and diffusion-weighted imaging have potential for differentiating benign from malignant lesions but need more refinement [5,21-23]. Even when MRI cannot characterize the type of lesion, it remains very useful for percutaneous biopsy and surgical planning.

### **Positron Emission Tomography**

Positron emission tomography (PET) scanning has shown promise in helping differentiate benign from malignant soft-tissue lesions [24]. However, Shin et al [24] have found significant differences in the average SUVmax (maximum standard uptake value) between benign and

malignant groups; there is significant overlap in individual tumor types reflecting variegated metabolic activity in different lesions and complicating myxoid and necrotic components with low metabolic activity. This study included a variety of lesion types, with low numbers of individual entities that could provide information regarding evaluation of specific tumor types (eg, lipoid) for malignant potential. Therefore, the role of PET scanning for evaluating soft-tissue tumors has yet to be established. It is unlikely that an SUV acquired from a PET examination could be relied upon to obviate biopsy at this point. However, information from a PET examination could be used for other purposes; for example, PET/CT fusion images could be used to plan biopsy, targeting areas with more metabolic activity that may give higher diagnostic yield. PET scanning has been used mainly for evaluating metastatic disease and follow-up of treated lesions.

### **Invasive Techniques**

Arthrography or invasive techniques are also rarely indicated, if at all, for evaluating soft-tissue masses. Popliteal cysts or communicating cystic lesions can be identified by introducing contrast material into the joints. However, this procedure is rarely performed today. With few exceptions, such as arteriovenous malformations or hemangiomas, angiography is also not frequently performed for the detection or staging of soft-tissue lesions [5].

### **Summary**

- As a general rule, MRI is the technique of choice for evaluating patients with suspected soft-tissue masses [2,10,12,14].
- CT may be of greater value in patients who demonstrate subtle cortical bone involvement or soft-tissue calcifications on routine radiographs.
- An alternative technique may have to be used on some patients because of their size, or other factors such as claustrophobia, the presence of certain metallic or electrical implants, or inability to remain motionless for the length of an MRI examination due to pain, Parkinson's disease, etc. CT would be selected in most situations.
- Advanced imaging modalities provide complementary information and, depending on lesion type and presentation, multiple modalities may be required for diagnostic and preprocedure evaluation.

### **Anticipated Exceptions**

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m<sup>2</sup>), and almost never in other patients. There is growing literature regarding NSF.

Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m<sup>2</sup>. For more information, please see the [ACR Manual on Contrast Media](#) [25].

### Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria<sup>®</sup> [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼☼	0.1-1 mSv	0.03-0.3 mSv
☼☼☼	1-10 mSv	0.3-3 mSv
☼☼☼☼	10-30 mSv	3-10 mSv
☼☼☼☼☼	30-100 mSv	10-30 mSv

\*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

### Supporting Document(s)

- [ACR Appropriateness Criteria<sup>®</sup> Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

### References

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.