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American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Metastatic Bone Disease**

Variant 1: **Stage 1 carcinoma of the breast. Initial presentation, asymptomatic.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray radiographic survey whole body	1		☢ ☢ ☢
Percutaneous biopsy area of interest	1		Varies
MRI area of interest without IV contrast	1		O
MRI area of interest without and with IV contrast	1		O
Tc-99m bone scan whole body	1		☢ ☢ ☢
Myelography and post myelography CT spine	1		☢ ☢ ☢ ☢
FDG-PET/CT skull base to mid-thigh	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: **Stage 2 carcinoma of the breast. Initial presentation, with back and hip pain.**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9	To be done first to evaluate for presence of lesions suspicious for metastatic disease.	☢ ☢ ☢
X-ray spine and hip	9	Radiographs obtained after bone scan if needed for further lesion characterization.	☢ ☢ ☢
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and the results of the PET examination will influence the use of systemic treatment.	☢ ☢ ☢ ☢
Tc-99m bone scan whole body with SPECT hip and spine	1		☢ ☢ ☢
Myelography and post myelography CT spine	1		☢ ☢ ☢ ☢
CT hips and spine without IV contrast	1		☢ ☢ ☢
CT hips and spine with IV contrast	1		☢ ☢ ☢
CT hips and spine without and with IV contrast	1		☢ ☢ ☢ ☢
X-ray radiographic survey whole body	1		☢ ☢ ☢
MRI hip and spine without IV contrast	1		O
MRI hip and spine without and with IV contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Metastatic Bone Disease**

Variant 3: **Breast carcinoma. Follow-up bone scan reveals single "hot" lesion in spine.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray spine hot area(s)	9		☢☢
MRI spine without IV contrast	9	If radiographs are negative.	O
FDG-PET/CT skull base to mid-thigh	5	If results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
MRI spine without and with IV contrast	1	Contrast can be useful if there is concern for extraosseous extension of tumor.	O
Myelography and post myelography CT spine	1		☢☢☢☢
Percutaneous biopsy spine	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
CT spine without IV contrast	1		☢☢☢
CT spine with IV contrast	1		☢☢☢
CT spine without and with IV contrast	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 4: **Breast carcinoma. Three "hot" areas in spine revealed by bone scan. No back pain.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray spine hot area(s)	9		☢☢
MRI spine without IV contrast	9	If radiographs are negative.	O
FDG-PET/CT skull base to mid-thigh	5	If results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
SPECT spine	5	SPECT may be added to bone scan in equivocal lesions.	☢☢☢
MRI spine without and with IV contrast	1	Contrast can be useful if there is concern for extraosseous extension of tumor.	O
Percutaneous biopsy spine	1		Varies
Myelography and post myelography CT spine	1		☢☢☢☢
CT spine hot area without IV contrast	1		☢☢
CT spine hot area with IV contrast	1		☢☢
CT spine hot area without and with IV contrast	1		☢☢☢
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Metastatic Bone Disease**

Variant 5: **History of treated breast carcinoma. Now has single "hot" lesion in the sternum revealed by bone scan.**

Radiologic Procedure	Rating	Comments	RRL*
CT sternum without IV contrast	9		☢ ☢ ☢
MRI sternum without IV contrast	8	If patient can tolerate prone imaging. Use of opposed-phase sequence is helpful to assess for marrow-obliterating process.	O
CT sternum with IV contrast	7	Contrast may be useful to delineate any soft-tissue extension and to direct biopsy.	☢ ☢ ☢
MRI sternum without and with IV contrast	7	Contrast may be useful to delineate any soft-tissue extension and to direct biopsy.	O
X-ray sternum	5	Difficult area to image with radiographs.	☢ ☢
FDG-PET/CT skull base to mid-thigh	5	If results of the PET examination will influence the use of systemic treatment.	☢ ☢ ☢ ☢
Tc-99m bone SPECT sternum	1		☢ ☢ ☢
CT sternum without and with IV contrast	1		☢ ☢ ☢
X-ray radiographic survey whole body	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 6: **Patient with known bone metastatic disease (carcinoma of the breast). Presenting with pathological fracture of a femur on radiography.**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢ ☢ ☢
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and the results of the PET examination will influence the use of systemic treatment.	☢ ☢ ☢ ☢
SPECT femur	1		☢ ☢ ☢
X-ray radiographic survey whole body	1		☢ ☢ ☢
CT femur without IV contrast	1		☢ ☢
CT femur with IV contrast	1		☢ ☢
CT femur without and with IV contrast	1		☢ ☢ ☢
MRI femur without IV contrast	1		O
MRI femur without and with IV contrast	1		O
X-ray femur	1		☢
Percutaneous biopsy femur	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Metastatic Bone Disease**

Variant 7: **Prostate nodule on physical examination proven to be a well- or moderately differentiated carcinoma and PSA <20 mg/ml. Patient asymptomatic.**

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without IV contrast	1		O
MRI area of interest without and with IV contrast	1		O
CT area of interest without IV contrast	1		Varies
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
X-ray radiographic survey whole body	1		☢ ☢ ☢
Tc-99m bone scan whole body	1		☢ ☢ ☢
FDG-PET/CT skull base to mid-thigh	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 8: **Prostate nodule on physical examination proven to be a poorly differentiated carcinoma or PSA ≥20 mg/ml. Patient asymptomatic.**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢ ☢ ☢
CT area of interest without IV contrast	1		Varies
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
X-ray radiographic survey whole body	1		☢ ☢ ☢
MRI area of interest without IV contrast	1		O
MRI area of interest without and with IV contrast	1		O
FDG-PET/CT skull base to mid-thigh	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Metastatic Bone Disease**

Variant 9: **Patient with known malignancy, with back pain and partially collapsed vertebra on radiography. Otherwise healthy.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without IV contrast	9	To differentiate osteoporotic collapse from destructive lesion.	O
Tc-99m bone scan whole body with SPECT spine	8	To detect additional lesions.	☢☢☢
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and the results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
MRI spine without and with IV contrast	1		O
CT spine without IV contrast	1		☢☢☢
CT spine with IV contrast	1		☢☢☢
CT spine without and with IV contrast	1		☢☢☢☢
Percutaneous biopsy spine	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 10: **1 cm lung nodule. Non-small-cell carcinoma found at needle biopsy. Now coming for staging and resection.**

Radiologic Procedure	Rating	Comments	RRL*
FDG-PET/CT skull base to mid-thigh	9		☢☢☢☢
Tc-99m bone scan whole body	4	Not needed if PET imaging is performed for initial nodule workup.	☢☢☢
MRI chest without IV contrast	1		O
MRI chest without and with IV contrast	1		O
X-ray radiographic survey whole body	1		☢☢☢
CT chest without IV contrast	1		☢☢☢
CT chest with IV contrast	1		☢☢☢
CT chest without and with IV contrast	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Metastatic Bone Disease**

Variant 11: **Patient with multiple myeloma presenting with acute low back pain.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray lumbar spine	9		☢ ☢ ☢
MRI lumbar spine without IV contrast	8	Important if neurologic symptoms are present. Can help differentiate benign from malignant fractures.	O
X-ray radiographic survey whole body	2	If there has been a long interval since last bone survey.	☢ ☢ ☢
Tc-99m bone scan whole body	1		☢ ☢ ☢
CT lumbar spine without IV contrast	1		☢ ☢ ☢
CT lumbar spine with IV contrast	1		☢ ☢ ☢
CT lumbar spine without and with IV contrast	1		☢ ☢ ☢ ☢
MRI lumbar spine without and with IV contrast	1		O
FDG-PET/CT skull base to mid-thigh	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 12: **Young patient with osteosarcoma of long bone, coming for staging. Chest CT normal. Looking for bone metastases.**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢ ☢ ☢
MRI area of interest without IV contrast	9	MRI of surrounding region to evaluate for small skip metastases.	O
MRI area of interest without and with IV contrast	9	Contrast can be useful for delineating the soft-tissue extent of the primary osteosarcoma.	O
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and MRI is equivocal, and if results of the PET examination will influence the use of systemic treatment.	☢ ☢ ☢ ☢
Tc-99m bone scan whole body with SPECT area of interest	1	SPECT may be added to nuclear medicine in equivocal lesions.	☢ ☢ ☢
CT area of interest without IV contrast	1		Varies
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
X-ray radiographic survey whole body	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Metastatic Bone Disease**

Variant 13: **Osteosarcoma, resected clear margins. Chemotherapy, asymptomatic. Six-month follow-up after treatment to rule out bone metastases.**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢ ☢ ☢
CT area of interest without IV contrast	1		Varies
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
X-ray radiographic survey whole body	1		☢ ☢ ☢
MRI area of interest without IV contrast	1		O
MRI area of interest without and with IV contrast	1		O
Tc-99m bone scan whole body with SPECT area of interest	1		☢ ☢ ☢
FDG-PET/CT skull base to mid-thigh	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 14: **Female, 8 weeks pregnant, with known primary, now suspected of having bone metastasis. She wants to continue with the pregnancy.**

Radiologic Procedure	Rating	Comments	RRL*
MRI whole body without IV contrast	9	Should be done first due to lack of ionizing radiation.	O
X-ray area of interest	9	With appropriate shielding. Helpful to evaluate risk of pathologic fracture.	Varies
CT area of interest without IV contrast	2	If involving an extremity. With appropriate shielding.	Varies
Tc-99m bone scan whole body	2		☢ ☢ ☢
MRI whole body without and with IV contrast	1		O
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
X-ray radiographic survey whole body	1		☢ ☢ ☢
FDG-PET/CT skull base to mid-thigh	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

METASTATIC BONE DISEASE

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Summary of Literature Review

Introduction/Background

There are several imaging and interventional techniques for the initial detection and follow-up of metastatic bone disease: radiography, radionuclide bone scanning, computed tomography (CT), magnetic resonance imaging (MRI), fine-needle aspiration, and core-needle biopsy. Newer techniques include fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET), FDG-PET/CT, and whole-body MRI [1-3].

Except for a few limitations, radionuclide bone scanning remains the primary imaging examination used to detect osseous metastasis. It has been repeatedly shown to be more sensitive than radiography [4]. Bone scans are sensitive in detecting osseous abnormalities, but they are nonspecific. After an abnormality has been detected, it should be radiographed to make sure it does not represent a benign process such as osteoarthritis, inflammatory arthritis, or fracture [5]. One of the major advantages of radionuclide bone scanning is that it allows for a total body survey. This is important because approximately 13% of metastatic lesions occur in the appendicular skeleton in regions that are usually not included on a skeletal survey [6]. Krishnamurthy et al [6] pointed out that most metastatic skeletal lesions are asymptomatic and that the serum alkaline phosphatase level is a poor indicator of early metastases. Highly aggressive metastases may show "cold" or photopenic areas on a bone scan. Multiple myeloma can show photopenic lesions or a negative bone scan [7,8]. Bone scans can also be relatively insensitive in detecting skeletal lesions due to Langerhans cell histiocytosis (histiocytosis X), and radiographic surveys are recommended for patients with this disease [9,10]. Diffuse bony metastasis may present with a pattern of intense uniform radionuclide uptake (superscan), which has the potential to be misinterpreted as a negative examination.

Solitary sites of increased radionuclide uptake in patients with known malignancy are a common occurrence, and they may pose a diagnostic problem because of the nonspecific nature of these abnormalities on bone scintigraphy. On the other hand, Boxer et al [11] reported that approximately 21% of patients with breast cancer relapsed with a solitary bone lesion, most commonly in the spine. The spine was the commonest site for both solitary and multiple metastases. Tumeh et al [12] reported that a solitary rib metastasis in cancer patients is uncommon and that 90% of "hot" rib lesions on bone scan are due to benign causes. A solitary sternal "hot" lesion in a patient with breast carcinoma has an 80% probability of being due to metastatic disease [13]. When a patient with a known primary tumor develops a solitary lesion on a bone scan, further diagnostic evaluation should be undertaken, starting with radiography and, if that is not diagnostic, proceeding to CT, MRI, or even biopsy [14,15]. Some authors advocate single-photon-emission computed tomography (SPECT) imaging as an effective method for differentiating malignant from benign lesions in the spine [16] and for further characterizing equivocal lesions on bone scan throughout the body [17].

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Breast Cancer

In stage 1 breast carcinoma where bone scintigraphy is usually negative, most authorities believe that routine baseline and follow-up bone scans are probably unwarranted because of the very low true positive yield [18,19]. The panel does not recommend any imaging studies of the skeleton in asymptomatic patients with stage 1 carcinoma of the breast when they present initially. Bone scanning, SPECT [20], FDG-PET [21,22], and PET/CT [23-25] have been shown to be useful in the preoperative staging and postoperative follow-up of stage 2, 3, and 4 breast carcinoma. FDG-PET has higher specificity than bone scintigraphy for metastases [26].

If a patient with stage 2 breast carcinoma presents with back and hip pain, the panel recommends radiography of the back and hip and radionuclide bone scan [27]. Other studies may be needed depending on the results of the radiographs and bone scan. In patients with known breast carcinoma who are discovered to have a single "hot" area in the spine on bone scan, the panel recommends radiography of the "hot" area. If radiography is negative, the panel recommends MRI. For lesion localization and needle guidance, a CT scan is recommended if a needle biopsy is warranted. The panel recommends adding SPECT imaging if the planar radionuclide bone scan is equivocal. In patients discovered to have multiple "hot" lesions in the spine, the panel recommends radiography of these "hot" lesions; MRI is also recommended if the radiographic examination is negative. A CT scan becomes necessary if a needle biopsy is to be performed.

For a "hot" lesion of the sternum in a patient with known breast carcinoma, the panel recommends CT or MRI to help in the diagnosis. Radiographs are less useful for evaluation due to overlapping structures in this region. MRI should be performed with the patient prone to minimize respiratory artifact, and the use of an opposed-phase (also referred to as in-and-out-of-phase) sequence is suggested to best assess for marrow replacement by tumor. CT is useful for localization if fine-needle aspiration or core biopsy is required or anticipated.

Long-Bone Fracture

In a patient with known metastatic carcinoma presenting with a pathological fracture of a long bone on radiography, the panel recommends a radionuclide bone scan to look for other metastatic sites in the skeleton. CT or MRI can be useful for surgical planning and assessment of pathologic fracture risk in other regions [28].

Prostate Cancer

Studies have shown that for staging and follow-up of patients with prostate carcinoma, radionuclide bone scans are not necessary unless the prostate-specific antigen (PSA) is ≥20 mg/ml or the primary tumor is poorly differentiated [29-32]. For routine staging purposes (no bone pain), the panel agrees with these studies. Thus, the panel recommends a radionuclide bone scan for patients with a PSA ≥20 mg/ml or with a poorly differentiated primary tumor. The role of FDG-PET/CT and other PET isotopes continues to develop for staging [33-35].

Non-Small-Cell Lung Cancer

In patients with non-small-cell carcinoma of the lung, bone is one of the most common sites for early extrathoracic spread. Some of these bony metastases are asymptomatic. The exclusion of bone metastases is important in the initial preoperative staging of lung cancer, although it is not clear from the literature whether bone scans should be performed routinely or only when clinical indicators suggest skeletal metastases [36,37]. The panel currently recommends a radionuclide bone scan of the skeleton in patients coming for staging after needle biopsy of a lung nodule revealed a non-small-cell carcinoma. However, in patients with non-small-cell carcinoma of the lung who have received or will be receiving an FDG-PET study as part of their initial workup, a radionuclide bone scan is not necessary [1,38]. The PET/CT literature supports this technique, showing that it has better accuracy than bone scintigraphy for staging non-small-cell lung carcinoma, especially for bone metastases [39-41].

Primary Bone Tumors

Bone metastases are very uncommon at initial presentation in patients with primary malignant bone tumors; therefore radionuclide bone scan is not indicated. Bone scanning has been shown not to be useful in differentiating between benign and malignant lesions or in defining the local extent of a malignant tumor reliably [42,43]. Osteosarcoma and Ewing sarcoma are probably the only exceptions; although the yield of imaging for metastases at the time of diagnosis is small, the presence of an occasional metastasis could substantially affect the treatment of the patient [44,45]. The panel concurs with these reports, and it recommends a radionuclide bone scan for patients with osteosarcoma or Ewing sarcoma at presentation for staging. In patients with osteosarcoma who have received adjuvant chemotherapy, 16% may develop asymptomatic osseous metastasis before lung

metastasis; therefore some authors suggest bone scans for routine follow-up [44,45]. The panel concurs with these reports, and it recommends a radionuclide bone scan for patients with osteosarcoma at follow-up and after tumor resection with clear margins and chemotherapy. FDG-PET has not been proven to replace chest CT and bone scanning as a staging modality for osteosarcoma [46].

Other Cancers

In patients with cancers that rarely metastasize to bone — such as cervical, endometrial, bladder, and gastrointestinal tract tumors — baseline scans are obtained only when the disease is advanced [47]. There is no consensus in the literature about the timing of follow-up scans in asymptomatic patients [48]. Some authors suggest a bone scan every 6 months for 1 year and then every 2 years. In clinical practice, most medical and radiation oncologists request follow-up bone scans only a) in asymptomatic patients with evidence of progressive disease (ie, rising carcinoembryonic antigen or alkaline phosphatase values), b) for restaging the disease in patients with local recurrence, and c) in patients with symptoms that are potentially of osseous origin [47]. SPECT, SPECT/CT, or PET with various isotopes may also be useful depending on the primary tumor type [49].

Radiography is frequently used to screen for metastatic sites in multiple myeloma and Langerhans cell histiocytosis (histiocytosis X), but generally it is considered insensitive to screen for asymptomatic metastases [7-10]. In patients with multiple myeloma who present with acute low-back pain, the panel recommends radiographs of the lumbosacral spine or bone survey if the interval since the last bone survey is long. MRI is useful in patients with neurological findings. The panel believes that the only time when radionuclide bone scan (with or without SPECT) would be needed in cases of multiple myeloma is when strontium 89 treatment is being considered.

Vertebral Column

The vertebral column deserves special consideration. It is the most common site of skeletal metastasis, and cord compression from metastasis is among the most dreaded complications of cancer [11]. MRI has proven advantages over all other imaging modalities, including myelography and CT myelography, for detecting these conditions [5,15]. One limitation of MRI has been its inability to consistently differentiate an acute traumatic or acute osteopenic compression fracture from a pathologic fracture, although certain characteristics can be suggestive in differentiating the two [50]. The presence of enhancement on MRI has also not been proven to be a distinguishing feature [50].The use of diffusion-weighted MRI has been shown to be effective in differentiating benign osteopenic vertebral collapse from malignant collapse, but the efficacy of this technique is still controversial and it has not gained widespread use [51-55].

The role of FDG-PET and FDG-PET/CT has been assessed in metastatic disease of the spine. In patients with lung cancer, studies have shown that FDG-PET has better specificity than bone scans using Tc-99m methylene diphosphonate (MDP) tracer, but similar sensitivity for detecting osseous metastatic disease [1]. Additionally, FDG-PET/CT has better specificity for detecting metastatic involvement of the spine than FDG-PET. FDG-PET/CT allows precise localization of bone lesions and associated soft-tissue involvement with potential neurologic significance [3].

Whole-Body MRI

As MRI sequences continue to evolve, there is emerging evidence showing that whole-body MRI is feasible and that it could replace bone scintigraphy for detecting metastatic bone disease. Proponents of this technique indicate that whole-body MRI is equal to [56,57] or more sensitive and specific than bone scintigraphy or PET/CT [58-60]. In addition to bone metastases, whole-body MRI can demonstrate silent metastases in the brain, lungs, and liver [61]. Whole-body MRI is also comparable in cost to bone scintigraphy [62]. No ionizing radiation is involved with whole-body MRI, making it especially suited for pregnant patients with suspected bony metastasis [2].

Depending on whether the lesion is lytic, blastic, or associated with a soft-tissue mass, fine-needle aspiration or core biopsy can be used to arrive at a definitive diagnosis in patients suspected of having metastasis of known or unknown origin. Needle biopsy is also helpful in suspected tumor recurrence and to differentiate metastasis from osteonecrosis in previously irradiated bone [63-66].

Summary

- Radionuclide bone scanning is the most widely used primary imaging examination for detecting osseous metastasis.

- After an abnormality has been detected, radiographs should be obtained to make sure the abnormality does not represent a benign process.
- If radiography is not diagnostic, additional lesion workup with MRI, CT, SPECT, or FDG-PET/CT is highly variable and should be based on the clinical situation and lesion location.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation
- ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound
- ACR Guidance Document for Safe MR Practices
- ACR Manual on Contrast Media

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® 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 "Varies".		

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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