



## Complete Summary

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### GUIDELINE TITLE

Bone tumors.

### BIBLIOGRAPHIC SOURCE(S)

Morrison WB, Dalinka MK, Daffner RH, DeSmet AA, El-Khoury GY, Kneeland JB WB, Manaster BJ, Pavlov BN, Rubin DA, Schneider R, Steinbach LS, Weissman BN, Haralson RH, Expert Panel on Musculoskeletal Imaging. Bone tumors. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 5 p. [25 references]

### GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Berquist TH, Dalinka MK, Alazraki N, Daffner RH, DeSmet AA, el-Khoury GY, Goergen TG, Keats TE, Manaster BJ, Newberg A, Pavlov H, Haralson RH, McCabe JB, Sartoris D. Bone tumors. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):261-4.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

## \*\* REGULATORY ALERT \*\*

### FDA WARNING/REGULATORY ALERT

**Note from the National Guideline Clearinghouse:** This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- [May 23, 2007, Gadolinium-based Contrast Agents](#): The addition of a boxed warning and new warnings about the risk of nephrogenic systemic fibrosis (NSF) to the full prescribing information for all gadolinium-based contrast agents (GBCAs).

## COMPLETE SUMMARY CONTENT

\*\* REGULATORY ALERT \*\*

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## SCOPE

### **DISEASE/CONDITION(S)**

Bone tumors

### **GUIDELINE CATEGORY**

Diagnosis

### **CLINICAL SPECIALTY**

Nuclear Medicine  
Oncology  
Radiology

### **INTENDED USERS**

Health Plans  
Hospitals  
Managed Care Organizations  
Physicians  
Utilization Management

### **GUIDELINE OBJECTIVE(S)**

To evaluate the appropriateness of initial radiologic examinations for bone tumors

### **TARGET POPULATION**

- Patients suspected of bone tumors
- Patients with bone tumors

### **INTERVENTIONS AND PRACTICES CONSIDERED**

1. X-ray
2. Nuclear medicine (NUC), bone scan
3. Magnetic resonance imaging (MRI)
4. Ultrasound (US)
5. Computed tomography (CT), with and without contrast
6. Invasive (INV), angiography

7. Positron emission tomography (PET)

## **MAJOR OUTCOMES CONSIDERED**

Utility of radiologic examinations in differential diagnosis

## **METHODOLOGY**

### **METHODS USED TO COLLECT/SELECT EVIDENCE**

Searches of Electronic Databases

### **DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE**

The guideline developer performed literature searches of peer-reviewed medical journals, and the major applicable articles were identified and collected.

### **NUMBER OF SOURCE DOCUMENTS**

The total number of source documents identified as the result of the literature search is not known.

### **METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE**

Weighting According to a Rating Scheme (Scheme Not Given)

### **RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE**

Not stated

### **METHODS USED TO ANALYZE THE EVIDENCE**

Systematic Review with Evidence Tables

### **DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE**

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

### **METHODS USED TO FORMULATE THE RECOMMENDATIONS**

Expert Consensus (Delphi)

### **DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS**

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed to reach agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by the participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1 to 9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by this Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

## **RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS**

Not applicable

## **COST ANALYSIS**

A formal cost analysis was not performed and published cost analyses were not reviewed.

## **METHOD OF GUIDELINE VALIDATION**

Internal Peer Review

## **DESCRIPTION OF METHOD OF GUIDELINE VALIDATION**

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

# **RECOMMENDATIONS**

## **MAJOR RECOMMENDATIONS**

**ACR Appropriateness Criteria®**

**Clinical Condition: Primary Bone Tumors, Suspected**

**Variant 1: Screening, first study.**

<b>Radiologic Exam Procedure</b>	<b>Appropriateness Rating</b>	<b>Comments</b>
X-ray	9	Absolute requirement in patient with suspected bone lesion.
NUC, bone scan	1	
MRI	1	
US	1	Not indicated as initial study.
CT	1	Not indicated as initial study.
INV, Angiography	1	
<b><i>Appropriateness Criteria Scale</i></b> <b>1 2 3 4 5 6 7 8 9</b> <b>1 = Least appropriate 9 = Most appropriate</b>		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Variant 2: Persistent symptoms, but radiograph negative.**

<b>Radiologic Exam Procedure</b>	<b>Appropriateness Rating</b>	<b>Comments</b>
MRI	9	Contrast may be useful, depends on expertise and institutional preference.
NUC, bone scan	4	Good option if patient cannot have MRI. Non- specific, MRI more specific and sensitive.
CT, without contrast	3	If MRI not available. Useful to evaluate cortex and trabecular pattern.
US	1	
<b><i>Appropriateness Criteria Scale</i></b> <b>1 2 3 4 5 6 7 8 9</b> <b>1 = Least appropriate 9 = Most appropriate</b>		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Clinical Condition: Primary Bone Tumors (Excluding Osteoid Osteoma)**

**Variant 3: Definitely benign on radiographs.**

<b>Radiologic Exam Procedure</b>	<b>Appropriateness Rating</b>	<b>Comments</b>
MRI	1	
CT	1	
US	1	
NUC, bone scan	1	
<b><i>Appropriateness Criteria Scale</i></b> <b>1 2 3 4 5 6 7 8 9</b> <b>1 = Least appropriate 9 = Most appropriate</b>		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Clinical Condition: Primary Bone Tumors, Suspected**

**Variant 4: Clinically suspected osteoid osteoma.**

<b>Radiologic Exam Procedure</b>	<b>Appropriateness Rating</b>	<b>Comments</b>
X-ray	9	Necessary. Follow with CT if positive.
CT, without contrast	9	Contrast not needed
NUC, bone scan	6	Very sensitive but non-specific. Good for localization if lesion is occult radiographically.
MRI	6	CT is more useful but diagnosis can often be made with MRI. Contrast may improve nidus identification.
CT, with and without contrast	2	
US	1	
<b><i>Appropriateness Criteria Scale</i></b> <b>1 2 3 4 5 6 7 8 9</b> <b>1 = Least appropriate 9 = Most appropriate</b>		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Variant 5: Suspicious for malignant characteristics on radiograph.**

<b>Radiologic Exam Procedure</b>	<b>Appropriateness Rating</b>	<b>Comments</b>
MRI	9	Contrast can provide more information. Useful for vascularity and necrotic areas.
CT, with and without contrast	5	May be useful if MRI not available or possible. Useful for evaluation of calcification, cortical breakthrough and pathological fractures.
NUC, bone scan	3	Probably not indicated, except to look for additional lesions.
PET	3	Can be useful for problem solving.
US	1	
INV, Angiography	1	Not indicated as a rule, unless anatomy required preoperatively. Could use MRA in some cases.
<b><i>Appropriateness Criteria Scale</i></b> <b>1 2 3 4 5 6 7 8 9</b> <b>1 = Least appropriate 9 = Most appropriate</b>		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

There are numerous imaging techniques for evaluating bone tumors. However, the routine radiograph remains the primary screening technique and is the least expensive for detection and histologic characterization of many tumor or tumor like conditions of bone. When a classically benign-appearing lesion is detected on routine radiographs, additional studies may not be required unless surgical intervention is contemplated and further anatomic information is required. In this setting either CT or MRI may be most appropriate for preoperative evaluation.

When routine radiographic features are indeterminate or the lesion is more aggressive and considered to be potentially malignant, additional imaging studies are frequently required. In the past, radionuclide imaging was used to evaluate bone lesions in this setting. However, today, because of MRI's improved anatomic detail and sensitivity, it is preferred over radionuclide studies. Early evaluation of MRI and CT demonstrated that MRI was superior for staging of bone tumors before treatment. One study described MR and CT features of bone tumors with regard to cortical destruction, marrow, soft-tissue, joint and neurovascular involvement. Another study reported MRI was superior to CT for cortical bone destruction in 4.5%, for marrow involvement in 25%, for soft tissue involvement in 31%, for joint involvement in 36.4%, and for invasion of neurovascular structures in 15.3% of patients studied. In the same categories MRI and CT were felt to be equal in 63 to 82% of patients. CT was superior to MRI for cortical bone destruction in 13.6% of patients and neurovascular involvement in 7.7% of patients. In most institutions the choice of imaging technique depends on patient

status as well as the location and type of suspected lesion. MRI is most typically used for staging lesions in the extremities. MR spectroscopy has potential to differentiate benign from malignant lesions, but more research is needed. CT is usually preferred when tumors are located within the periosteal or cortical regions, with flat bones with thin cortex and little marrow, and to better demonstrate tumor mineralization, which may be suspected from routine radiographs. For rib lesions, thin-section CT is useful to exclude benign fracture. CT is also preferred over MRI for detecting a characteristic central nidus in patients with suspected osteoid osteoma on radiographs. PET scanning has potential to differentiate metabolically active bone lesions from indolent ones, but this modality has mainly been used to detect metabolically active metastatic lesions or recurrences, or for preoperative evaluation of known sarcomas.

There are special considerations when dealing with suspected chondroid lesions. Intramedullary chondroid lesions appearing in the hands and feet are nearly always benign, and may present incidentally or as a pathological fracture. If the lesion is elsewhere it may be challenging by any imaging modality to differentiate a benign lesion from a low-grade malignancy. If there is pain related to the lesion, suspicion of malignancy should be high. One study suggests that imaging features including deep endosteal scalloping, cortical destruction, soft tissue mass (on CT or MRI), periosteal reaction (on radiographs) and marked uptake of radionuclide can be used to distinguish appendicular enchondroma from chondrosarcoma in at least 90% of cases. Another study suggests that radiographic signs cannot discriminate reliably between enchondroma and grade 1 chondrosarcoma, but that axial location and large size (greater than 5 cm) are the most reliable predictors of malignancy in this setting. An additional study suggests that dynamic contrast-enhanced MRI can assist in differentiating benign from malignant chondroid lesions, and other authors suggest that PET may be useful; however, these modalities have not been clearly established for this purpose. Protocol for follow-up of an asymptomatic, incidentally identified lesion has not been scientifically established. Authors such as Mirra's group suggest that risk of malignant transformation is increased for larger lesions, lesions in the axial skeleton, and in the setting of multiple lesions (e.g., Ollier's disease) and suggest radiographic follow-up for those with higher risk but stop short of making specific recommendations regarding interval and extent of follow-up.

Patients with symptoms related to the bone or joint with normal radiographs present a different problem. Though CT may be performed in this setting, a radionuclide bone scan may be more useful to localize the abnormality. MRI can be very useful in this setting not only to identify whether a lesion is present but also to define the nature of a lesion based on the features discussed above; as a result, MRI is generally preferred. If an osteoid osteoma is suspected, one study reported that CT was more accurate than MRI in 63% of cases. However, another study reported that dynamic contrast-enhanced MRI can improve conspicuity of osteoid osteoma compared to CT.

Other invasive imaging techniques, such as angiography, are not commonly required. One study compared MRI, CT, technetium-99m bone scans, and angiography for local staging of 56 patients with primary bone sarcomas. This study demonstrated that MRI was superior to CT and scintigraphy in defining the extent of bone involvement and was equal in accuracy to CT in demonstrating joint and cortical involvement. CT, MR, and angiography were compared for evaluating

neurovascular involvement. CT demonstrated a sensitivity of 33%, MR 100%, and angiography 83% with specificities of 93% for CT, 98% for MR, and 71% for angiography. This study concluded that MR was the technique of choice for evaluating and staging primary bone sarcomas, including neurovascular involvement. MRI is useful for determining tissue characteristics of a bone lesion, such as fat, hemorrhage, fibrous tissue or fluid levels; with gadolinium contrast, cystic or necrotic areas can be detected.

### **Anticipated Exceptions**

Routine radiographs remain the optimal screening technique. When lesions are characteristically benign, additional imaging may not be required unless needed for preoperative planning. The above data suggest that MRI is the preferred technique for staging of primary bone neoplasms but in some categories CT is equal or superior to MRI. CT is preferred for patients with suspected osteoid osteoma or subtle cortical abnormalities, and for evaluating lesion calcification or tumor matrix.

Additional exceptions for utilization of MRI include patient size and clinical status and the presence of certain metallic or electrical implants that may preclude the use of MRI.

### **Abbreviations**

- CT, computed tomography
- INV, invasive
- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- NUC, nuclear medicine
- PET, positron emission tomography
- US, ultrasound

### **CLINICAL ALGORITHM(S)**

Algorithms were not developed from criteria guidelines.

## **EVIDENCE SUPPORTING THE RECOMMENDATIONS**

### **TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS**

The recommendations are based on analysis of the current literature and expert panel consensus.

## **BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS**

### **POTENTIAL BENEFITS**

Selection of appropriate radiologic imaging procedures to evaluate patients with bone tumors or suspected of bone tumors

## POTENTIAL HARMS

Not stated

## QUALIFYING STATEMENTS

### QUALIFYING STATEMENTS

An American College of Radiology (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 exams 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 U.S. Food and Drug Administration (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.

## IMPLEMENTATION OF THE GUIDELINE

### DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

### IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about [availability](#), see the "Availability of Companion Documents" and "Patient Resources" fields below.

## INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

### IOM CARE NEED

Living with Illness

### IOM DOMAIN

Effectiveness

## IDENTIFYING INFORMATION AND AVAILABILITY

### **BIBLIOGRAPHIC SOURCE(S)**

Morrison WB, Dalinka MK, Daffner RH, DeSmet AA, El-Khoury GY, Kneeland JB WB, Manaster BJ, Pavlov BN, Rubin DA, Schneider R, Steinbach LS, Weissman BN, Haralson RH, Expert Panel on Musculoskeletal Imaging. Bone tumors. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 5 p. [25 references]

### **ADAPTATION**

Not applicable: The guideline was not adapted from another source.

### **DATE RELEASED**

1995 (revised 2005)

### **GUIDELINE DEVELOPER(S)**

American College of Radiology - Medical Specialty Society

### **SOURCE(S) OF FUNDING**

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

### **GUIDELINE COMMITTEE**

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

### **COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE**

*Panel Members:* William B. Morrison, MD; Murray K. Dalinka, MD; Richard H. Daffner, MD; Arthur A. De Smet, MD; George Y. El-Khoury, MD; John B. Kneeland, MD; B.J. Manaster, MD, PhD; Helene Pavlov, MD; David A. Rubin, MD; Robert Schneider, MD; Lynne S. Steinbach, MD; Barbara N. Weissman, MD; Robert H. Haralson III, MD

### **FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST**

Not stated

### **GUIDELINE STATUS**

This is the current release of the guideline.

This guideline updates a previous version: Berquist TH, Dalinka MK, Alazraki N, Daffner RH, DeSmet AA, el-Khoury GY, Goergen TG, Keats TE, Manaster BJ,

Newberg A, Pavlov H, Haralson RH, McCabe JB, Sartoris D. Bone tumors. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):261-4.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

## **GUIDELINE AVAILABILITY**

Electronic copies: Available in Portable Document Format (PDF) from the [American College of Radiology \(ACR\) Web site](#).

ACR Appropriateness Criteria® *Anytime, Anywhere*™ (PDA application). Available from the [ACR Web site](#).

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

## **AVAILABILITY OF COMPANION DOCUMENTS**

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the [American College of Radiology \(ACR\) Web site](#).

## **PATIENT RESOURCES**

None available

## **NGC STATUS**

This summary was completed by ECRI on May 6, 2001. The information was verified by the guideline developer as of June 29, 2001. This summary was updated by ECRI on March 27, 2006. This summary was updated by ECRI Institute on May 17, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Gadolinium-based contrast agents. This summary was updated by ECRI Institute on June 20, 2007 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents.

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Date Modified: 10/20/2008

