

**Primary Bone Tumors
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Sundaram M, McLeod RA. MR imaging of tumor and tumorlike lesions of bone and soft tissue. <i>AJR</i> 1990; 155(4):817-824.	12	N/A	To review role of MRI in the diagnosis and staging of tumors and tumor like lesions of bone and soft-tissue.	MRI reliably shows change in tumor volume after radiation or chemotherapy, but is less reliable in predicting the amount of tumor necrosis.	4
2. Assoun J, Richardi G, Railhac JJ, et al. Osteoid osteoma: MR imaging versus CT. <i>Radiology</i> 1994; 191(1):217-223.	9	19	To compare the value of CT and MRI in the diagnosis of osteoid osteoma.	CT more accurate than MRI in detection of the osteoid osteoma nidus in 63% of cases. MRI better than CT in showing intramedullary and soft-tissue changes in all cases. Statistically significant correlation between presence or absence of marrow or soft-tissue changes and treatment with anti-inflammatory medications (P<.05).	3
3. Zimmer WD, Berquist TH, McLeod RA, et al. Bone tumors: magnetic resonance imaging versus computed tomography. <i>Radiology</i> 1985; 155(3):709-718.	9	52	To compare MRI with CT in the diagnosis of bone tumors.	MR is of greatest value in evaluation of the peripheral skeleton, the medullary canal, soft-tissues, and postoperative tumor recurrence. With a 0.15-T magnet, MR is less useful in the evaluation of the axial skeleton and cortical bone.	3
4. Frank JA, Ling A, Patronas NJ, et al. Detection of malignant bone tumors: MR imaging vs scintigraphy. <i>AJR</i> 1990; 155(5):1043-1048.	9	106	Retrospective analysis. Patients with a known or suspected diagnosis of bone cancer were evaluated with scintigraphy and MRI to determine their sensitivities in the detection of bone disease.	Although MRI has better sensitivity in detecting focal disease, scintigraphy is still the most useful screening test for evaluating the entire skeleton. MR is recommended for clarification of scintigraphic findings when suspicion is high for tumor.	2
5. Bloem JL, Taminiau AH, Eulderink F, Hermans J, Pauwels EK. Radiologic staging of primary bone sarcoma: MR imaging, scintigraphy, angiography, and CT correlated with pathologic examination. <i>Radiology</i> 1988; 169(3):805-810.	9	56	Prospective evaluation of the relative value of MRI, CT, Tc-99m bone scintigraphy, and angiography in local tumor staging in patients with primary bone sarcoma.	MRI is the preferred modality. MRI was better than CT and scintigraphy in defining intraosseous tumor length and was as accurate as CT in demonstrating cortical bone and joint involvement. It was better than CT in demonstrating involvement of muscle compartments. MRI was also the best modality in exhibiting the relationship between tumor and major neurovascular bundles; however, these differences were not significant.	2
6. Hogeboom WR, Hoekstra HJ, Mooyaart EL, et al. MRI or CT in the preoperative diagnosis of bone tumours. <i>Eur J Surg Oncol</i> 1992; 18(1):67-72.	9	25	Prospective study to compare MRI with CT in the diagnosis of bone tumors.	MRI is the preferred modality. CT is adequate for skeletal lesions.	2

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7. Griffiths HJ, Galloway HR, Thompson RC, Jr., et al. The use of MRI in the diagnosis of benign and malignant bone and soft tissue tumours. <i>Australas Radiol</i> 1993; 37(1):35-39.	10	234 tumors	Assess MRI appearances in suspected soft-tissue tumors to differentiate benign from malignant tumors.	For suspected soft-tissue tumor, workup should be first by MRI and for suspected malignant bone tumor, workup should be radiographs followed by an MRI scan.	2
8. Seeger LL, Widoff BE, Bassett LW, Rosen G, Eckardt JJ. Preoperative evaluation of osteosarcoma: value of gadopentetate dimeglumine-enhanced MR imaging. <i>AJR</i> 1991; 157(2):347-351.	10	21	To determine if gadopentetate dimeglumine-enhanced MRI could assist in the preoperative evaluation of osteosarcoma. Correlated MRI results with tumor margins found at surgery.	Gadopentetate dimeglumine does not assist in defining tumor margins of osteosarcoma.	3
9. Wang CK, Li CW, Hsieh TJ, Chien SH, Liu GC, Tsai KB. Characterization of bone and soft-tissue tumors with in vivo 1H MR spectroscopy: initial results. <i>Radiology</i> 2004; 232(2):599-605.	10	36	To determine if in vivo detection of choline by using hydrogen 1 (1H) MR spectroscopy (MRS) with dynamic contrast material-enhanced MRI can help differentiate benign from malignant musculoskeletal tumors.	Choline was found significantly more commonly in malignant lesions. In vivo 1H MRS characterized bone and soft-tissue tumors, resulting in a sensitivity of 95%, specificity of 82%, and accuracy of 89% (P<.001).	2
10. Collins MS, Koyama T, Swee RG, Inwards CY. Clear cell chondrosarcoma: radiographic, computed tomographic, and magnetic resonance findings in 34 patients with pathologic correlation. <i>Skeletal Radiol</i> 2003; 32(12):687-694.	9	34	Retrospective review to analyze the imaging characteristics of clear cell chondrosarcoma using multiple modalities. Conventional radiographs, CT and MRI were used.	MRI was better than conventional radiographs for demonstrating the intramedullary extent of a lesion as well as soft-tissue extension. CT was useful for characterizing chondroid matrix.	2
11. Niitsu M, Takeda T. Solitary hot spots in the ribs on bone scan: value of thin-section reformatted computed tomography to exclude radiography-negative fractures. <i>J Comput Assist Tomogr</i> 2003; 27(4):469-474.	10	47	To categorize solitary, scintigraphy-positive and radiography-negative rib lesions and to explain the features of rib fractures by using thin-section reformatted helical CT.	Thin-section CT delineated minute, radiographically occult fractures of the rib.	2
12. Davies M, Cassar-Pullicino VN, Davies AM, McCall IW, Tyrrell PN. The diagnostic accuracy of MR imaging in osteoid osteoma. <i>Skeletal Radiol</i> 2002; 31(10):559-569.	10	43	Multicenter, retrospective study of MR findings to determine the diagnostic accuracy of MRI in osteoid osteoma.	Of the 43 cases, 9 were poorly visualized and 6 were not detected on MRI. Reliance on MRI alone may lead to misdiagnosis.	2
13. Klein MH, Shankman S. Osteoid osteoma: radiologic and pathologic correlation. <i>Skeletal Radiol</i> 1992; 21(1):23-31.	12	67	To review histologic features of trabecular thickness, reactive bone formation, proportion of fibrovascular stroma, ratio of osteoid and mineralized matrix and compare radiographic features.	No results stated.	3

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14. Aoki J, Watanabe H, Shinozaki T, et al. FDG PET of primary benign and malignant bone tumors: standardized uptake value in 52 lesions. <i>Radiology</i> 2001; 219(3):774-777.	10	52	To evaluate the SUV of FDG-PET in the differentiation of benign from malignant bone lesions.	Significant difference between benign and malignant lesions; however, some benign histiocytic and giant cell lesions had high uptake.	2
15. Bredella MA, Essary B, Torriani M, Ouellette HA, Palmer WE. Use of FDG-PET in differentiating benign from malignant compression fractures. <i>Skeletal Radiol</i> 2008; 37(5):405-413.	10	33	Retrospective analysis to evaluate the use of FDG-PET in differentiating benign from malignant compression fractures.	FDG-PET had sensitivity 86%, specificity 83%, PPV 84%, NPV 71%, and 92% accuracy. Statistically significant difference between standardized uptake values (SUV) of benign and malignant fractures (1.9 ± 0.97 for benign and 3.9 ± 1.52 for malignant fractures, $P < 0.001$). SUV of benign acute and chronic fractures were not statistically significant.	2
16. Dehdashti F, Siegel BA, Griffeth LK, et al. Benign versus malignant intraosseous lesions: discrimination by means of PET with 2-[F-18]fluoro-2-deoxy-D-glucose. <i>Radiology</i> 1996; 200(1):243-247.	10	20	To assess the ability of FDG-PET in differentiating benign from malignant intraosseous lesions.	FDG-PET is useful in differentiating benign from malignant strictly intraosseous lesions.	3
17. Lee FY, Yu J, Chang SS, Fawwaz R, Parisien MV. Diagnostic value and limitations of fluorine-18 fluorodeoxyglucose positron emission tomography for cartilaginous tumors of bone. <i>J Bone Joint Surg Am</i> 2004; 86-A(12):2677-2685.	10	27	To examine the glucose metabolism of cartilage tumors measured by PET and its correlation with histopathologic grades.	No significant difference between benign cartilage lesions and grade 1 chondrosarcomas; significant difference between benign/low grade lesions and high-grade lesions. For SUV of 2.3 for grade-II or III chondrosarcomas: PPV; 0.82 (95% CI: 0.48 to 0.97) and NPV; 0.96 (95% CI: 0.77 to 1.00).	2
18. Shin DS, Shon OJ, Byun SJ, Choi JH, Chun KA, Cho IH. Differentiation between malignant and benign pathologic fractures with F-18-fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography. <i>Skeletal Radiol</i> 2008; 37(5):415-421.	10	34	To evaluate the efficacy of FDG-PET/CT in differentiating malignant from benign pathologic fractures.	19 malignant and 15 benign. PET/CT had high (mean SUV(max) 12.0, range 4.3 to 45.7) FDG uptake in bone marrow in most cases (17/19). Benign had low FDG uptake (mean SUV(max) 2.9, range 0.6 to 5.5). Significant differences in pattern of intramedullary FDG uptake ($P < 0.001$) and in the mean SUV(max) ($P < 0.01$) between malignant and benign fractures. Sensitivity 89.5%, specificity 86.7 and diagnostic accuracy 88.2%.	2

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19. Shin DS, Shon OJ, Han DS, Choi JH, Chun KA, Cho IH. The clinical efficacy of (18)F-FDG-PET/CT in benign and malignant musculoskeletal tumors. <i>Ann Nucl Med</i> 2008; 22(7):603-609.	10	91	To determine the clinical efficacy of FDG-PET/CT in benign and malignant musculoskeletal tumors.	Significant difference in SUV(max) between benign and malignant musculoskeletal tumors in total (P<0.002), soft-tissue tumors (P<0.05), and bone tumors (P<0.02). Sensitivity, specificity, and diagnostic accuracy were 80%, 65.2%, and 73% in total with cutoff SUV(max) 3.8, 80%, 68.4%, and 75% in the soft-tissue tumors with cutoff SUV(max) 3.8, and 80%, 63%, and 70% in the bone tumors with cutoff SUV(max) 3.7. Many false-positive and false negative lesions.	2
20. Murphey MD, Flemming DJ, Boyea SR, Bojescul JA, Sweet DE, Temple HT. Enchondroma versus chondrosarcoma in the appendicular skeleton: differentiating features. <i>Radiographics</i> 1998; 18(5):1213-1237; quiz 1244-1215.	13	92 with enchondromas, 95 with chondrosarcomas	Retrospective review to identify statistically significant differentiating clinical and imaging features of enchondroma and chondrosarcoma in lesions.	Features: Pain related to the lesion, deep endosteal scalloping (greater than two-thirds of cortical thickness), cortical destruction and soft-tissue mass (at CT or MRI), periosteal reaction (at radiography), and marked uptake of radionuclide (greater than the anterior iliac crest). All of these features strongly suggested the diagnosis of chondrosarcoma. These criteria allow distinction of appendicular enchondroma and chondrosarcoma in at least 90% of cases.	2
21. Geirnaerd MJ, Hogendoorn PC, Bloem JL, Taminiou AH, van der Woude HJ. Cartilaginous tumors: fast contrast-enhanced MR imaging. <i>Radiology</i> 2000; 214(2):539-546.	10	37	Prospective study to differentiate between benign and malignant cartilaginous tumors with fast contrast material-enhanced MRI.	Differentiating benign from malignant tumors on the basis of early and exponential enhancement was possible with a sensitivity 61%, specificity 95%, PPV 92%, and NPV 72%.	2
22. Geirnaerd MJ, Hermans J, Bloem JL, et al. Usefulness of radiography in differentiating enchondroma from central grade 1 chondrosarcoma. <i>AJR</i> 1997; 169(4):1097-1104.	13	35 enchondromas, 43 central grade 1 chondrosarcomas	Evaluate clinical symptoms and radiographic features that allow radiologists to differentiate between enchondroma and central grade 1 chondrosarcoma.	Location in the axial skeleton and size >5 cm are the most reliable predictors of central grade 1 chondrosarcoma.	2
23. Feldman F, Van Heertum R, Saxena C, Parisien M. 18FDG-PET applications for cartilage neoplasms. <i>Skeletal Radiol</i> 2005; 34(7):367-374.	10	29	To assess the value of FDG-PET in defining aggressive cartilage neoplasms, particularly those with problematic or borderline histologic, imaging and clinical characteristics.	In 26 operated cases the overall sensitivity of whole-body FDG-PET in separating benign and malignant lesions was 90.9% (10/11), specificity 100% (18/18) and accuracy 96.6%.	2

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24. Brien EW, Mirra JM, Kerr R. Benign and malignant cartilage tumors of bone and joint: their anatomic and theoretical basis with an emphasis on radiology, pathology and clinical biology. I. The intramedullary cartilage tumors. <i>Skeletal Radiol</i> 1997; 26(6):325-353.	13	845 cases of benign and 356 cases of malignant	To review clinical, radiologic and histologic features of intramedullary cartilaginous lesions.	Benign cartilaginous lesions are unique because the epiphyseal plate has been implicated in the etiology of osteochondroma, enchondroma (single or multiple), periosteal chondromas and chondroblastoma.	2
25. Liu PT, Chivers FS, Roberts CC, Schultz CJ, Beauchamp CP. Imaging of osteoid osteoma with dynamic gadolinium-enhanced MR imaging. <i>Radiology</i> 2003; 227(3):691-700.	9	11	Retrospective review to compare dynamic gadolinium-enhanced T1-weighted MRI with nonenhanced T1-weighted and T2-weighted MRI and thin-section CT for the demonstration of osteoid osteomas.	Improved conspicuity of osteoid osteomas seen using dynamic gadolinium-enhanced MRI.	3
26. Weatherall PT, Maale GE, Mendelsohn DB, Sherry CS, Erdman WE, Pascoe HR. Chondroblastoma: classic and confusing appearance at MR imaging. <i>Radiology</i> 1994; 190(2):467-474.	13	22	Retrospective analysis to define the characteristics of chondroblastoma at MRI and findings that are diagnostic for chondroblastoma.	MRI findings of chondroblastoma allow accurate diagnosis and help avoid confusion with infection and aggressive neoplasms.	3
27. Campbell RS, Grainger AJ, Mangham DC, Beggs I, Teh J, Davies AM. Intraosseous lipoma: report of 35 new cases and a review of the literature. <i>Skeletal Radiol</i> 2003; 32(4):209-222.	11	35 110-meta-analysis	To identify imaging features of intraosseous lipomas on radiographs, MRI and CT, and review their histological features.	Fat necrosis and cyst formation identified on MRI is common (67%), and more frequent in the os calcis. Although correlation occurs between the histological and radiological features of intraosseous lipomas, some discrepancies occur in the radiological appearances of lipomas in different sites.	2
28. Frick MA, Sundaram M, Unni KK, et al. Imaging findings in desmoplastic fibroma of bone: distinctive T2 characteristics. <i>AJR</i> 2005; 184(6):1762-1767.	13	95	Retrospective review to examine imaging findings of desmoplastic fibroma. Emphasis on short T2 and its value as a diagnostic sign in fibroosseous lesions of the bone.	Low T2 signal within lesion may indicate fibrous tissue.	2
29. Murphey MD, wan Jaovisidha S, Temple HT, Gannon FH, Jelinek JS, Malawer MM. Telangiectatic osteosarcoma: radiologic-pathologic comparison. <i>Radiology</i> 2003; 229(2):545-553.	9	40	Retrospective review to compare imaging findings of telangiectatic osteosarcomas.	Radiographs showed geographic bone lysis, a wide zone of transition, and matrix mineralization. CT demonstrated low attenuation, MRI demonstrated high signal intensity on T2-weighted images, and both demonstrated hemorrhage. Viable sarcomatous tissue surrounding hemorrhagic and/or necrotic regions was best seen at contrast material-enhanced CT and MRI, with thick peripheral, septal, and nodular enhancement in all cases. Subtle matrix mineralization in this viable tissue was best seen at CT. An associated soft-tissue mass was also seen in 19/25 cases (76%) at CT and in 24/27 cases (89%) at MRI.	2

* See Last Page for Key

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30. American College of Radiology. <i>Manual on Contrast Media</i> . Available at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx .	15	N/A	Guidance document on contrast media to assist radiologists in recognizing and managing risks associated with the use of contrast media.	N/A	3

Evidence Table Key

Study Type Key

Numbers 1-7 are for studies of therapies while numbers 8-15 are used to describe studies of diagnostics.

1. Randomized Controlled Trial — Treatment
2. Controlled Trial
3. Observation Study
 - a. Cohort
 - b. Cross-sectional
 - c. Case-control
4. Clinical Series
5. Case reviews
6. Anecdotes
7. Reviews

8. Randomized Controlled Trial — Diagnostic
9. Comparative Assessment
10. Clinical Assessment
11. Quantitative Review
12. Qualitative Review
13. Descriptive Study
14. Case Report
15. Other (Described in text)

Strength of Evidence Key

- Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
- Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
- Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
- Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.