Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Abe H, Nakamura M, Takahashi S, Maruoka S, Ogawa Y, Sakamoto K. Radiation-induced insufficiency fractures of the pelvis: evaluation with 99mTc-methylene diphosphonate scintigraphy. *AJR* 1992; 158(3):599-602.	4	80	Patients with uterine cancer, radiated; bone scans retrospectively reviewed to evaluate the frequency of pelvic insufficiency fractures caused by radiotherapy and to study the appearance of the fractures on bone scans.	29/80 abnormal–insufficiency fracture in 27, metastases in 2; 85% had >1 fracture, 67% symmetric; proven by CT or follow-up. Recognize the frequency of fracture in this population, diagnosed by pattern on bone scan; differentiate from metastases if necessary by CT.	2
2. Daffner RH, Pavlov H. Stress fractures: current concepts. *AJR* 1992; 159(2):245-252.	12	N/A	To review imaging modalities used to diagnose stress fractures.	• Stress fractures occur at specific sites, associated with specific activities. • Bone scans show stress fracture days-weeks earlier than radiograph and differentiate between osseous and ST injury. • CT only ancillary. • MRI findings often non-specific and confusing.	4
3. De Smet AA, Neff JR. Pubic and sacral insufficiency fractures: clinical course and radiologic findings. *AJR* 1985; 145(3):601-606.	15	9	To describe common features of pubic insufficiency fractures.	8 patients had combined sacral and pubic fractures; one had only sacral alar fractures. In 3 patients the sacral fractures preceded the pubic fractures by 3-4 months. All 9 patients had skeletal demineralization due to metabolic bone disease, radiation therapy, or multiple myeloma.	4
4. Greaney RB, Gerber FH, Laughlin RL, et al. Distribution and natural history of stress fractures in U.S. Marine recruits. *Radiology* 1983; 146(2):339-346.	10	250	Prospective study. To evaluate U.S. Marine recruits presenting with lower extremity pain with bone scintigraphy and radiography of symptomatic or scan-positive locations.	Bone scintigraphy is an early and accurate means for the detection of lower extremity stress fractures, even in the absence of radiographic findings.	2
5. Harrington T, Crichton KJ, Anderson IF. Overuse ballet injury of the base of the second metatarsal. A diagnostic problem. *Am J Sports Med* 1993; 21(4):591-598.	14	8	To examine the diagnosis and treatment of foot injuries in ballerinas.	Good clinical results in a group of 8 ballerinas who had early diagnosis and treatment.	4
6. Kiss ZS, Khan KM, Fuller PJ. Stress fractures of the tarsal navicular bone: CT findings in 55 cases. *AJR* 1993; 160(1):111-115.	13	54	Retrospective review. To present CT findings in 55 cases of tarsal navicular stress fracture before and after treatment and to describe the CT protocol used.	• 53 fractures (96%) were partial. 43 partial fractures were linear, 5 were linear with bone fragments, and 5 were rim defects with ossicles. In 13 cases (24%) the fracture was small, 10% or less of bone height. Firm cortical union was noted in 10 (32%) of 31 by 4 months. • CT scanning is a suitable method for detecting navicular stress fracture and for performing follow-up examinations.	3

* See Last Page for Key

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
7. Peh WC, Evans NS. Pelvic insufficiency fractures in the elderly. *Ann Acad Med Singapore* 1993; 22(5):818-822.	14	6	To describe the clinical and radiological features of elderly patients with pelvic insufficiency fractures.	Radiographs are usually unhelpful or may be misleading. Isotope bone scans are the most sensitive modality, demonstrating complete or partial H-shaped sacral uptake, parasymphyseal uptake, or a combination of both. CT is useful for confirming these fractures and excluding malignant disease.	4
8. Geslien GE, Thrall JH, Espinosa JL, Older RA. Early detection of stress fractures using 99mTc-polyphosphate. *Radiology* 1976; 121(3 Pt. 1):683-687.	13	200	To describe clinical experience with 99mTc-polyphosphate scintigraphy in patients with suspected stress fractures.	• Bone scintigraphy is sensitive enough to detect the physiological alterations found in stress fractures. • Bone scintigraphy decreased morbidity in patients.	3
9. Zwas ST, Elkanovitch R, Frank G. Interpretation and classification of bone scintigraphic findings in stress fractures. *J Nucl Med* 1987; 28(4):452-457.	13	310	To evaluate scintigraphic findings for severity of lesions by extent of the visualized bone response, ranging from ill-defined cortical lesions with slightly increased activity (I) to well-defined intramedullary transcortical lesions with intensely increased activity (IV) in stress fractures.	• In 235 patients, 391 stress fractures were diagnosed. 40% of the lesions were asymptomatic. Most of the lesions were in the tibiae (72%), and 87% of the patients had 1 or 2 lesions, while 13% had 3 to 5 lesions. • Early recognition of mild stress fracture scintigraphic patterns representing the beginning of pathologic bone response to stress enabled a prompt and effective treatment to prevent progression of lesions, protracted disability, and complications.	3
10. Matin P. The appearance of bone scans following fractures, including immediate and long-term studies. *J Nucl Med* 1979; 20(12):1227-1231.	10	204	To study bone scans performed on patients with different types of fractures in the acute, subacute and healing stages.	80% of all fractures were abnormal by 24 hours, and 95% by 72 hours, after injury. 3 distinct temporally related phases were noted on bone scans as sequential studies showed a gradual return to normal. The minimum time for a fracture to return to normal on a bone scan was 5 months. Approximately 90% of the fractures returned to normal by 2 years after injury.	2
11. Matin P. Basic principles of nuclear medicine techniques for detection and evaluation of trauma and sports medicine injuries. *Semin Nucl Med* 1988; 18(2):90-112.	13	N/A	To describe the various patterns of abnormality in stress fractures, tibial stress syndrome (shin splints), compartment syndrome, enthesopathy, and traumatic fractures. The characteristic scintigraphic appearance of joint injuries, muscle injuries (rhabdomyolysis), and radionuclide arthrography is discussed and the way the scan patterns change with time in these various disorders is described.	Nuclear medicine skeletal imaging can be used to differentiate between acute muscle injury, tibial stress syndrome, skeletal injury (periosteal reaction, stress fracture, and traumatic fracture) or an abnormality that is entirely associated with the joint or connective tissue. This differential diagnosis is easier if the nuclear medicine procedure is performed within a few days after the onset of injury.	3

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
12. Wilcox JR, Jr., Moniot AL, Green JP. Bone scanning in the evaluation of exercise-related stress injuries. *Radiology* 1977; 123(3):699-703.	10	34	Bone scintigraphy used to evaluate patients with physical findings and history of stress fracture of the lower extremity.	21 had abnormal studies, 11 involving the femoral neck, 9 the tibia, and 1 the femur. All of these had abnormal scintiscans prior to or at the time of the appearance of radiographic changes. Of the 9 with abnormal tibial studies, radiographic changes never evolved in 3. No false negatives were found among the 13 with normal scintiscans.	3
13. Scott S, Alazraki N, Manaster B. Failure of bone scanning to detect fractures in a woman on chronic steroid therapy. *Skeletal Radiol* 1984; 12(3):204-207.	14	1	Case report of a patient on steroids with false bone scan of intertrochanteric hip fracture.	A non-revealing bone scan in the presence of steroid therapy should not be considered highly accurate.	4
14. Scott SM, Manaster BJ, Alazraki N, Wooten WW, Murphy K. Technetium-99m imaging of bone trauma: reduced sensitivity caused by hydrocortisone in rabbits. *AJR* 1987; 148(6):1175-1178.	10	29 (rabbits)	To evaluate the effect of hydrocortisone on the sensitivity of 99mTc-scintigraphy for the detection of bone trauma in three groups of rabbits: control group that received no hydrocortisone, a low-dose group that received 0.8 mg/kg/day, and a high-dose group that received 20 mg/kg/day.	• Mean sensitivity for detecting fractures in control animals was 95% at 48 hours and 100% at all other times. • Mean sensitivity for rabbits given the high dose of hydrocortisone was 41% at 48 hours. • Mean sensitivity for the low-dose group was 75% at 48 hours. • Sensitivity in both groups treated with hydrocortisone improved with time. At 3 weeks, the mean was 93% in the low-dose group and 83% in the high-dose group. • 99mTc-scintigraphy may be less sensitive in detecting bone trauma in patients on glucocorticoid therapy than in patients in the general population.	3
15. Groves AM, Cheow HK, Balan KK, et al. 16-Detector multislkce CT in the detection of stress fractures: a comparison with skeletal scintigraphy. Clin radiology 2005;60:100-1105	9	26	To test the hypothesis that the improved resolution afforded by 16-detector CT provides better stress fracture detection when compared with skeletal scintigraphy.	Scintigraphy detected more stress fractures. Multidetector CT should not be used as the initial investigative tool for suspected stress fractures.	2
16. Hatem SF, Recht MP, Profitt B. MRI of Little Leaguer's shoulder. *Skeletal Radiol* 2006; 35(2):103-106.	14	4	To describe MRI findings and review the literature of young baseball players with stress injury of the proximal humerus.	MRI clearly shows the osseous and marrow changes in these patients with shoulder pain.	4

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
17. Deutsch AL, Mink JH, Waxman AD. Occult fractures of the proximal femur: MR imaging. *Radiology* 1989; 170(1 Pt 1):113-116.	10	23	To determine role of MRI in the evaluation of patients with occult hip fracture.	MRI correctly demonstrated fracture in 9 of 9 patients; the precise configuration of the fracture line was delineated in 8 patients. MRI was useful in excluding fractures in 14/14 patients. MRI can provide a rapid, cost-effective, and anatomically precise diagnosis of hip fracture in patients with normal or equivocal initial radiographs.	3
18. Ishibashi Y, Okamura Y, Otsuka H, Nishizawa K, Sasaki T, Toh S. Comparison of scintigraphy and magnetic resonance imaging for stress injuries of bone. *Clin J Sport Med* 2002; 12(2):79-84.	9	31	Prospective study to compare scintigraphy, radiographs, and MRI in evaluation of stress injuries of bone and evaluate changes of these findings with time correlated with clinical symptoms.	MRI is less invasive, provides more information than scintigraphy, and is recommended for initial diagnosis and assessment stages of stress injury of bone.	2
19. Kiuru MJ, Pihlajamaki HK, Hietanen HJ, Ahovuo JA. MR imaging, bone scintigraphy, and radiography in bone stress injuries of the pelvis and the lower extremity. *Acta Radiol* 2002; 43(2):207-212.	9	50	To compare MRI, radiography and bone scintigraphy in the diagnosis of stress injuries to bones of the pelvis and lower extremity.	• Sensitivity of radiography was 56%, specificity 94%, accuracy 67%, PPV 95%, and NPV 48%. The kappa value for radiography and bone scintigraphy was fair (0.39). • Sensitivity of MRI was 100%, specificity 86%, accuracy 95%, PPV 93% and NPV 100%. The kappa value for MRI and bone scintigraphy was very good (0.89). • MRI is more sensitive than two-phase bone scintigraphy, and MRI should be used as the gold standard in the assessment of stress injuries of bone. Radiography reveals mainly the late phases of bone stress injuries, such as stress fracture and callus.	2
20. Lassus J, Tulikoura I, Konttinen YT, Salo J, Santavirta S. Bone stress injuries of the lower extremity: a review. *Acta Orthop Scand* 2002; 73(3):359-368.	12	N/A	To review etiology, pathogenesis, diagnosis, and treatment of bone stress injuries.	Diagnosis has been traditionally based on clinical, radiographic and scintigraphic examinations, but MRI has become increasingly important. High resolution MRI is valuable for the grading of bone stress injuries. Most bone stress injuries heal with closed treatment, but surgery is necessary in some cases.	4
21. Lee JK, Yao L. Stress fractures: MR imaging. *Radiology* 1988; 169(1):217-220.	14	5	To report five cases of stress fracture studied with high-field-strength MRI and describe MR findings by which stress fracture can be distinguished from lesion of occult intraosseous fracture.	MRI showed bandlike areas of very low-signal intensity in the intramedullary space, which were continuous with the cortex. On the T2 weighted images; 3 cases of intramedullary areas and 2 cases of juxtacortical and/or subperiosteal areas of high signal intensity.	4

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
22. Meyers SP, Wiener SN. Magnetic resonance imaging features of fractures using the short tau inversion recovery (STIR) sequence: correlation with radiographic findings. *Skeletal Radiol* 1991; 20(7):499-507.	13	28	To analyze patients who had radiographic evidence of fracture and were examined with T1-weighted spin echo (SE) and short tau inversion recovery (STIR) sequences to determine the MRI characteristics of fracture using STIR pulse sequences.	MRI using T1-weighted SE and STIR sequences can consistently demonstrate prominent signal abnormalities at fracture sites including those in which radiographic signs are subtle.	3
23. Ahovuo JA, Kiuru MJ, Visuri T. Fatigue stress fractures of the sacrum: diagnosis with MR imaging. *Eur Radiol* 2004; 14(3):500-505.	13	380	Retrospective study to describe the MRI findings and clinical observations in fatigue stress fractures of the sacrum in Finnish military recruits.	MRI detected signal abnormalities compatible with sacral stress fractures in 31 patients. The linearity of the fracture lines on MRI is characteristic. MRI should be the procedure of choice for evaluating for sacral stress fractures.	2
24. Anderson MW. Imaging of upper extremity stress fractures in the athlete. *Clin Sports Med* 2006; 25(3):489-504, vii.	12	N/A	To review the most common sites of stress injuries in the upper extremity, their underlying pathophysiology, and their spectrum of imaging findings.	Although a three-phase bone scan is highly sensitive in this regard, MRI has become the study of choice at most centers.	4
25. Aoki Y, Yasuda K, Tohyama H, Ito H, Minami A. Magnetic resonance imaging in stress fractures and shin splints. *Clin Orthop Relat Res* 2004; (421):260-267.	10	22	To determine whether MRI could differentiate between stress fractures and shin splints in athletes.	MRI showed osseous and marrow abnormalities in 8 patients with stress fractures. These findings were absent in the 14 patients with shin splints.	3
26. Gaeta M, Minutoli F, Scribano E, et al. CT and MR imaging findings in athletes with early tibial stress injuries: comparison with bone scintigraphy findings and emphasis on cortical abnormalities. *Radiology* 2005; 235(2):553-561.	9	42	To prospectively compare CT, MRI, and bone scintigraphy in athletes with clinically suspected early tibial stress injury.	Sensitivity of MRI, CT, and bone scintigraphy was 88%, 42%, and 74%, respectively. Specificity, accuracy, PPV, and NPV were 100%, 90%, 100%, and 62%, respectively, for MRI and 100%, 52%, 100%, and 26%, respectively, for CT. MRI is the single best technique in assessment of patients with suspected tibial stress injuries.	2
27. Lee SH, Baek JR, Han SB, Park SW. Stress fractures of the femoral diaphysis in children: a report of 5 cases and review of literature. *J Pediatr Orthop* 2005; 25(6):734-738.	14	5	Small report on patients with stress fractures without a history of recent increase in activity.	MRI is most useful in diagnosing stress fractures when other causes of leg pain are being considered.	4
28. Muthukumar T, Butt SH, Cassar-Pullicino VN. Stress fractures and related disorders in foot and ankle: plain films, scintigraphy, CT, and MR Imaging. *Semin Musculoskelet Radiol* 2005; 9(3):210-226.	12	N/A	To review the various diagnostic imaging techniques in evaluating patients with suspected stress fractures.	MRI is the new “gold standard” and the modality of choice in evaluating for early stress injury.	4

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
29. Sofka CM. Imaging of stress fractures. *Clin Sports Med* 2006; 25(1):53-62, viii.	12	N/A	To review the use of CT, nuclear scintigraphy US, and MRI in patients with suspected stress fractures.	Imaging should begin with radiography of the area of question. CT is useful for fine bony detail and endosteal scalloping. Nuclear imaging shows area of stress remodeling. MRI provides the most comprehensive evaluation of stress injuries.	4
30. Ahovuo JA, Kiuru MJ, Kinnunen JJ, Haapamaki V, Pihlajamaki HK. MR imaging of fatigue stress injuries to bones: intra- and interobserver agreement. *Magn Reson Imaging* 2002; 20(5):401-406.	10	50	Retrospective study to evaluate different MRI sequences for sensitivity, specificity, accuracy, and observer agreement in stress injuries of bone.	Rates for MRI sensitivity were 27%-96%, for specificity 65%-100%, and for diagnostic accuracy 58%-97%. MRI is a valid means of revealing the presence of stress injuries to bone and their staging. Observer agreement is good to excellent when using T2-weighted images and STIR images, while T1-weighed images are of lesser value.	2
31. Yao L, Johnson C, Gentili A, Lee JK, Seeger LL. Stress injuries of bone: analysis of MR imaging staging criteria. *Acad Radiol* 1998; 5(1):34-40.	10	35	To examine the prognostic value of MRI in stress injuries of bone.	• Fracture line or cortical signal abnormality indicates a more severe stress injury and portends a longer time to heal. • Muscle edema is a favorable prognostic finding and indicates a shorter recovery time.	3
32. Fayad LM, Kawamoto S, Kamel IR, et al. Distinction of long bone stress fractures from pathologic fractures on cross-sectional imaging: how successful are we? *AJR* 2005; 185(4):915-924.	9	59	To define CT and MRI features that distinguishes pathologic fractures from stress fractures and to compare the performance of CT and MRI with radiography.	• MRI is useful for distinguishing between pathologic fractures and stress fractures, especially after inconclusive radiographic findings. Pathologic fractures exhibit well-defined T1 marrow alterations, endosteal scalloping and adjacent soft-tissue abnormalities. Stress fractures tend to be linear in their distribution. • CT is useful for depicting and confirming fracture lines and for characterizing the nature of periosteal reaction or cortical destruction, inconclusive on radiographs.	2
33. Hayes CW, Conway WF, Sundaram M. Misleading aggressive MR imaging appearance of some benign musculoskeletal lesions. *Radiographics* 1992; 12(6):1119-1134; discussion 1135-1116.	13	12	To present examples of benign bone neoplasms and nonneoplastic conditions that had misleading aggressive appearances with MRI and review the importance of radiographic interpretation, clinical background, and optimization of MRI techniques.	• Over-reliance on MRI may lead to misdiagnosis of stress fracture as an aggressive lesion. • Radiography remains the single most valuable modality in determining a differential diagnosis for bone lesions.	3

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
34. Blomlie V, Lien HH, Iversen T, Winderen M, Tvera K. Radiation-induced insufficiency fractures of the sacrum: evaluation with MR imaging. *Radiology* 1993; 188(1):241-244.	10	18	Retrospective study. To report MRI findings of patients with radiation-induced fractures of the sacrum.	In 17 patients, the lesions were consistent with edema and had diffuse low signal intensity on T1-weighted images and diffuse high signal intensity on short-inversion-time inversion-recovery images. In one patient, bilateral sacral wing fractures were demonstrated directly as fairly well-defined linear zones. The alae sacri were involved in all patients; 16 patients had bilateral lesions.	3
35. Brahme SK, Cervilla V, Vint V, Cooper K, Kortman K, Resnick D. Magnetic resonance appearance of sacral insufficiency fractures. *Skeletal Radiol* 1990; 19(7):489-493.	14	5	To evaluate MRI findings of patients with sacral insufficiency fractures.	MRI is sensitive but not specific in detecting sacral insufficiency fractures.	4
36. Cooper KL. Insufficiency stress fractures. *Curr Probl Diagn Radiol* 1994; 23(2):29-68.	12	N/A	To review imaging of insufficiency stress fractures.	A thorough familiarity with the characteristic appearance and location of stress fractures assures the correct diagnosis.	4
37. Soubrier M, Dubost JJ, Boisgard S, et al. Insufficiency fracture. A survey of 60 cases and review of the literature. Joint Bone Spine 2003; 70(3):209-218.	13	60	Retrospective review to report findings on risk factors, location, clinical course, and imaging of insufficiency fractures.	• Radiography showed a fracture line or osteocondensation in 65% (39/60) of cases. • Scintigraphy was positive in 87.5% of cases (21/24), showing a fracture line (15) or a callus (6). • Bone CT scan was positive in 98.1% (54/55) of cases. • Insufficiency fractures occur in elderly women with osteoporosis and most commonly in the pelvis. • Since radiologic signs are inconstant, scintigraphy is the choice procedure.	3
38. Grangier C, Garcia J, Howarth NR, May M, Rossier P. Role of MRI in the diagnosis of insufficiency fractures of the sacrum and acetabular roof. *Skeletal Radiol* 1997; 26(9):517-524.	9	20	Retrospective study. To review the risk factors and the radiological appearance of insufficiency fractures of the sacrum and acetabular roof. Radiography, bone scintigrams, MRI, and bone densitometry were performed.	• In 3 cases the CT scan performed 10-25 days after onset of symptoms was interpreted as normal. • MRI performed a few days after the CT scan showed in each of these 3 patients a fracture line with a band of edema. • Scintigraphy was very sensitive, but the H-shaped pattern of sacral uptake, specific for an insufficiency fracture, was detected in only 3/16 cases.	3

Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae
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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
39. Otte MT, Helms CA, Fritz RC. MR imaging of supra-acetabular insufficiency fractures. *Skeletal Radiol* 1997; 26(5):279-283.	10	12	To report MRI appearance of supra-acetabular insufficiency fractures and how they can be differentiated from metastatic disease.	MRI is a useful tool for diagnosing supra-acetabular insufficiency fractures. The characteristic MRI appearance of these fractures can prevent additional diagnostic studies and therapy in most instances.	3
40. Disler DG, McCauley TR, Ratner LM, Kesack CD, Cooper JA. In-phase and out-of-phase MR imaging of bone marrow: prediction of neoplasia based on the detection of coexistent fat and water. *AJR* 1997; 169(5):1439-1447.	10	30	Assess images to determine if gradient-echo MRI with TE can help predict neoplastic or nonneoplastic lesions in bone marrow. Two reviewers were used.	• The relative signal-intensity ratios were 1.03 +/- 0.13 for the neoplastic group and 0.62 +/- 0.13 for the nonneoplastic group (p<.0001). • A ratio cutoff value of 0.81 resulted in a 95% sensitivity and a 95% specificity for detection of neoplasm. Both reviewers achieved 100% sensitivity and 94%-100% specificity for detection of neoplasms. • In-phase and out-of-phase gradient-echo MRI of bone marrow signal-intensity abnormalities can help predict the likelihood of neoplastic or nonneoplastic lesions.	2
41. Eito K, Waka S, Naoko N, Makoto A, Atsuko H. Vertebral neoplastic compression fractures: assessment by dual-phase chemical shift imaging. *J Magn Reson Imaging* 2004; 20(6):1020-1024.	10	108	To compare normal vertebrae with vertebrae with neoplastic compression fractures by means of opposed-phase and in-phase gradient-echo imaging.	• Mean SIR of 3 groups (group 1: 0.46 +/- 0.14; group 2: 0.63 +/- 0.21; and group 3: 1.02 +/- 0.11) were significantly different according to the Tukey-Kramer test (P<0.01). • Opposed-phase and in-phase T1-W gradient-echo MRI of vertebral SI abnormalities can help predict the nature of compression fractures.	2
42. Erly WK, Oh ES, Outwater EK. The utility of in-phase/opposed-phase imaging in differentiating malignancy from acute benign compression fractures of the spine. *AJNR Am J Neuroradiol* 2006; 27(6):1183-1188.	10	25	Prospective study to determine whether MRI can differentiate signal intensity in benign and malignant fractures of the spine.	21 patients had 49 vertebral lesions. 20 malignant and 29 benign. Significant difference in signal intensity benign compression fractures and malignancy on in-phase/opposed-phase MRI.	2
43. Bencardino JT, Kassarjian A, Palmer WE. Magnetic resonance imaging of the hip: sports-related injuries. *Top Magn Reson Imaging* 2003; 14(2):145-160.	12	N/A	To review use of conventional radiography and MRI in recreational and professional athletes with painful hip joints.	In patients with suspected sports related stress fractures of the hip and normal radiographs, MRI of the entire pelvis should be the next imaging modality for evaluation.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
44. Kiuru MJ, Pihlajamaki HK, Ahovuo JA. Fatigue stress injuries of the pelvic bones and proximal femur: evaluation with MR imaging. *Eur Radiol* 2003; 13(3):605-611.	10	340	To determine the imaging and patient characteristics of stress injuries in patients with hip or pelvic pain and clinically suspected stress injury bases on MRI results.	The sensitivity of radiography was 37%, specificity 79%, accuracy 60%, PPV 59% and NPV 61%. The kappa value for agreement between radiography and MRI was poor (0.17, p=0.0008). Patients suffering from stress-related hip pain, MRI revealed bone stress injuries in 40%; of these, 60% were located in the proximal femur and 40% in the pelvic bones. MRI of the entire pelvis and proximal femurs should be used to evaluate patients suspected of having stress injuries presenting with hip or pelvic pain.	2
45. Quinn SF, McCarthy JL. Prospective evaluation of patients with suspected hip fracture and indeterminate radiographs: use of T1-weighted MR images. *Radiology* 1993; 187(2):469-471.	10	20	Patients with suspected hip fracture and indeterminate radiographs were prospectively evaluated to assess the diagnostic efficacy of T1-weighted MRI.	T1-weighted MRI can enable diagnosis or exclusion of hip fracture whenever radiographs are indeterminate.	2
46. Feydy A, Drape J, Beret E, et al. Longitudinal stress fractures of the tibia: comparative study of CT and MR imaging. *Eur Radiol* 1998; 8(4):598-602.	9	15	Retrospective study to compare the efficacy of CT and MRI in longitudinal stress fractures of the tibia.	MRI had higher sensitivity than CT in the detection of bone marrow edema (73 vs 18 %) and soft tissue lesions (87 vs 9 %). This may cause a misleading aggressive appearance on MRI. CT remains the best imaging modality for diagnosis of longitudinal stress fractures of the tibia. However, MRI findings should be known to obviate the performance of CT or bone biopsy.	3
47. Shearman CM, Brandser EA, Parman LM, et al. Longitudinal tibial stress fractures: a report of eight cases and review of the literature. *J Comput Assist Tomogr* 1998; 22(2):265-269.	14	8 36 cases from literature	Review cases and literature to evaluate the imaging findings of longitudinal stress fractures to determine the modality most useful for diagnosis.	• Radiographs should be the initial modality of study. • Bone scan is sensitive for detection of stress injuries, but additional imaging is needed in virtually all cases as it is nonspecific. • CT and MR demonstrate nearly equal diagnostic accuracy.	4
48. Romani WA, Perrin DH, Dussault RG, Ball DW, Kahler DM. Identification of tibial stress fractures using therapeutic continuous ultrasound. *J Orthop Sports Phys Ther* 2000; 30(8):444-452.	9	26	Results from the visual analog scale were compared to MRI findings to determine if 1 MHz of continuous US can diagnose tibial stress fractures.	Continuous US demonstrated a sensitivity of 0% and specificity of 100%. A protocol using visual analog scores after the application of 1 MHz continuous ultrasound is not sensitive for identifying subjects with tibial stress fractures.	3

Evidence Table Key

S 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.