

**Acute Hip Pain — Suspected Fracture
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Brauer CA, Coca-Perraillon M, Cutler DM, Rosen AB. Incidence and mortality of hip fractures in the United States. <i>JAMA</i> 2009; 302(14):1573-1579.	Review/Other-Dx	109,805 respondents, 786,717 hip fractures	To examine trends in hip fracture incidence and resulting mortality over 20 years in the U.S. Medicare population.	Between 1986 and 2005, the annual mean number of hip fractures was 957.3 per 100,000 (95% CI, 921.7-992.9) for women and 414.4 per 100,000 (95% CI, 401.6-427.3) for men. The age-adjusted incidence of hip fracture increased from 1986 to 1995 and then steadily declined from 1995 to 2005. In women, incidence increased 9.0%, from 964.2 per 100,000 (95% CI, 958.3-970.1) in 1986 to 1050.9 (95% CI, 1045.2-1056.7) in 1995, with a subsequent decline of 24.5% to 793.5 (95% CI, 788.7-798.3) in 2005. In men, the increase in incidence from 1986 to 1995 was 16.4%, from 392.4 (95% CI, 387.8-397.0) to 456.6 (95% CI, 452.0-461.3), and the subsequent decrease to 2005 was 19.2%, to 369.0 (95% CI, 365.1-372.8). Age- and risk-adjusted mortality in women declined by 11.9%, 14.9%, and 8.8% for 30-, 180-, and 360-day mortality, respectively. For men, age- and risk-adjusted mortality decreased by 21.8%, 25.4%, and 20.0% for 30-, 180-, and 360-day mortality, respectively. Over time, patients with hip fracture have had an increase in all comorbidities recorded except paralysis. The incidence decrease is coincident with increased use of bisphosphonates.	4
2. Stevens JA, Anne Rudd R. Declining hip fracture rates in the United States. <i>Age Ageing</i> 2010; 39(4):500-503.	Review/Other-Dx	N/A	To analyze the national trends in hip fracture rates from 1990-2006 for people aged 65 years and older by both sex and 10-year age groups by using hospital discharge data.	Men's rates fell from 54.6 per 10,000 population in 1990 to 48.8 per 10,000 in 2006 (test for trend, P=0.007). However, this trend was only significant among men aged 85 and older (test for trend, P=0.005). Rates for women fell from 108.4 per 10,000 in 1990 to 91.7 per 10,000 in 2006 (test for trend, P<0.001). Examination by 10-year age groups found that the decline was significant only among women aged 75-84 (test for trend, P<0.001) and aged 85 and older (test for trend, P=0.001). For women in the oldest age group, rates peaked in 1997 and declined thereafter.	4

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3. U.S. Cancer Statistics Working Group. <i>United States Cancer Statistics: 1999–2007 Incidence and Mortality Web-based Report</i> . Atlanta (GA): Department of Health and Human Services, Centers for Disease Control and Prevention, and National Cancer Institute; 2010. Available at: http://apps.nccd.cdc.gov/uscs/ .	Review/Other-Dx	N/A	Report on the official federal statistics on cancer incidence from registries that have high-quality data and cancer mortality statistics for each year and 2004–2008 combined.	Results not stated in abstract.	4
4. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. <i>J Bone Miner Res</i> 2007; 22(3):465-475.	Review/Other-Dx	N/A	To evaluate osteoporosis-related fractures and associated costs across race/ethnicity, age groups, sex, and fracture types in the United States during 2005 and projects costs and fracture incidence to the year 2025.	More than 2 million incident fractures at a cost of \$17 billion are predicted for 2005. Total costs including prevalent fractures are more than \$19 billion. Men account for 29% of fractures and 25% of costs. Total incident fractures by skeletal site were vertebral (27%), wrist (19%), hip (14%), pelvic (7%), and other (33%). Total costs by fracture type were vertebral (6%), hip (72%), wrist (3%), pelvic (5%), and other (14%). By 2025, annual fractures and costs are projected to rise by almost 50%. The most rapid growth is estimated for people 65–74 years of age, with an increase >87%. An increase of nearly 175% is projected for Hispanic and other subpopulations.	4
5. Burge RT, King AB, Balda E, Worley D. Methodology for estimating current and future burden of osteoporosis in state populations: application to Florida in 2000 through 2025. <i>Value Health</i> 2003; 6(5):574-583.	Review/Other-Dx	N/A	To develop a methodology for estimating current and future costs of osteoporosis in state populations and applied it to Florida.	In Florida, 86,428 osteoporotic fractures were estimated to occur in the year 2000 at a cost of \$ 1,238,445,114. By 2025, the estimated number of incident fractures would increase to 151,622, at a cost of \$2,135,130,564.	4

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6. Melton LJ, 3rd, Gabriel SE, Crowson CS, Tosteson AN, Johnell O, Kanis JA. Cost-equivalence of different osteoporotic fractures. <i>Osteoporos Int</i> 2003; 14(5):383-388.	Review/Other-Dx	985 residents	To test the validity that fracture costs are proportional to fracture morbidity by calculating the excess costs attributable to different osteoporotic fractures and comparing them to previously published morbidity estimates for these fractures.	The overall median incremental (case minus control) cost in the succeeding year was \$2,390, with a particularly high incremental cost for hip fractures (\$11,241). There was fair concordance between the incremental cost of the different fractures, relative to hip fracture alone, and the previously published disutility associated with each fracture type relative to hip fracture. Overall, the incremental cost for all osteoporotic fractures combined was 46% greater than that for hip fractures alone in women and 47% greater in men. This is consistent with the earlier report that overall morbidity from all osteoporotic fractures combined is 47% and 39% greater in women and men, respectively, than the morbidity attributable solely to hip fractures.	4
7. Tosteson AN, Burge RT, Marshall DA, Lindsay R. Therapies for treatment of osteoporosis in US women: cost-effectiveness and budget impact considerations. <i>Am J Manag Care</i> 2008; 14(9):605-615.	Review/Other-Dx	N/A	To evaluate the cost-effectiveness of osteoporosis treatments for women at high fracture risk and estimate the population-level impact of providing bisphosphonate therapy to all eligible high-risk U.S. women.	Women treated with a bisphosphonate experienced fewer fractures and more QALYs compared with no therapy or teriperatide. Total costs were lowest for the untreated cohort, followed by risedronate, alendronate, ibandronate, and teriperatide in all risk groups except women aged 75 years with previous fracture. The incremental cost-effectiveness of risedronate compared with no therapy ranged from cost saving for the base case to \$66,722 per QALY for women aged 65 years with no previous fracture. Ibandronate and teriperatide were dominated in all risk groups. (A dominated treatment has a higher cost and poorer outcome.) Treating all eligible women with a bisphosphonate would cost an estimated additional \$5563 million (21% total increase) and would result in 390,049 fewer fractures (35% decrease). In the highest risk group, the additional cost of therapy was offset by other healthcare cost savings.	4

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8. Galloway HR, Meikle GR, Despois M. Patterns of injury in patients with radiographic occult fracture of neck of femur as determined by magnetic resonance imaging. <i>Australas Radiol</i> 2004; 48(1):21-24.	Review/Other-Dx	70 patient records	To review retrospectively authors' experiences with MRI in patients over the age of 50 who present to the emergency department with inability to weight bear following a fall and whose initial radiographs were normal.	Of these 70 patients, 23 (32.8%) had a fractured neck of femur and two patients had bilateral femoral neck fractures, giving a total of 25 fractures of the neck of femur. Of these 25 fractures, 15 (60%) were intertrochanteric fractures and 7 (28%) were subcapital fractures. There were 3 (12%) transcervical. On retrospective review of the radiographs of these fractures, 11 (44%) had findings suspicious for, but not conclusive of, fracture, 10 (40%) had no evidence of fracture, and in four (16%) plain radiographs were not available for review. Of the patients without evidence of fractured neck of femur, specific bony musculoskeletal pathology was found in 28 (40%). Of these 28 patients, 17 (61%) had insufficiency fractures of the pelvis. Of the remaining 17 (24%) patients, 11 (65%) had soft tissue abnormalities only, 7 (41%) had no fractures, no soft tissue abnormality and were otherwise normal. All patients with a fractured neck of femur or other specific bony pathology had soft tissue abnormalities for a total of 63 of 70 (90%) patients with soft tissue abnormalities.	4
9. Cannon J, Silvestri S, Munro M. Imaging choices in occult hip fracture. <i>J Emerg Med</i> 2009; 37(2):144-152.	Review/Other-Dx	N/A	To review the literature focused on hip fracture detection and discuss advantages and limitations of each major imaging modality.	Plain radiographs are usually sufficient for diagnosis as they are at least 90% sensitive for hip fracture. However, in the 3%-4% of emergency department patients having hip X-ray studies who harbor an occult hip fracture, the emergency physician must choose among several methods, each with intrinsic limitations, for further evaluation. These methods include CT, scintigraphy, and MRI.	4

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10. Feldman F, Staron RB. MRI of seemingly isolated greater trochanteric fractures. <i>AJR</i> 2004; 183(2):323-329.	Review/Other-Dx	37	To show that greater trochanteric fractures commonly perceived on routine radiographs as isolated are often neither isolated nor minor and that MRI can serve as a basis for more informed treatment by revealing the actual extent of such fractures in acute posttraumatic settings.	A pitfall in diagnosing seemingly isolated greater trochanteric fractures on routinely used imaging techniques lies in the fact that the injuries usually involve a large anatomic area. MRI more accurately defines the true geographic extent of greater trochanteric fractures sustained through acute trauma than do radiography and bone scintigraphy and thus could provide a more reliable basis for anticipating complications and for planning appropriate treatment.	4
11. Rizzo PF, Gould ES, Lyden JP, Asnis SE. Diagnosis of occult fractures about the hip. Magnetic resonance imaging compared with bone-scanning. <i>J Bone Joint Surg Am</i> 1993; 75(3):395-401.	Observational-Dx	62 patients	To compare MRI with bone-scanning for the diagnosis of occult fractures about the hip.	36 patients who had evidence of a fracture on the MRI study also had a positive bone scan initially. 23 patients who had a negative finding on the MRI study had a corresponding negative bone scan. Two additional patients had evidence of avascular necrosis of the femoral head on both the MRI and the bone scan, and they were managed non-operatively. One patient had a positive MRI and a negative bone scan 24 hours after admission. A repeat bone scan, which was made 6 days later, was positive for a fracture of the femoral neck and the patient was managed with internal fixation. MRI was as accurate as bone-scanning in the assessment of occult fractures of the hip and provides an early diagnosis of occult fractures about the hip and may decrease the length of the stay in the hospital by expediting definitive treatment.	3

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12. Koval KJ, Zuckerman JD. Hip Fractures: I. Overview and Evaluation and Treatment of Femoral-Neck Fractures. <i>J Am Acad Orthop Surg</i> 1994; 2(3):141-149.	Review/Other-Tx	N/A	To present an overview, evaluation and treatment of femoral-neck fractures.	Surgical management followed by early mobilization is the treatment of choice for most patients with hip fractures. However, all comorbid medical conditions, particularly cardiopulmonary and fluid- electrolyte imbalances, must be evaluated and stabilized prior to operative intervention. Nondisplaced femoral-neck fractures should be stabilized with multiple parallel lag screws or pins. The treatment of displaced femoral-neck fractures is based on the patient's age and activity level: young active patients should undergo open reduction and internal fixation; older, less active patients are usually treated with hemiarthroplasty, either uncemented or cemented. Regardless of treatment method, the goal is to return the patient to his or her prefracture level of function.	4
13. Dominguez S, Liu P, Roberts C, Mandell M, Richman PB. Prevalence of traumatic hip and pelvic fractures in patients with suspected hip fracture and negative initial standard radiographs--a study of emergency department patients. <i>Acad Emerg Med</i> 2005; 12(4):366-369.	Observational-Dx	895 patients	To determine the prevalence of hip and pelvic fractures in emergency department patients with hip pain and negative standard initial radiographs.	764/895 patients (85.3%) had follow-up completed (study group). Within the study group, 219 patients (29%) had evidence of fracture on initial radiographs. Of the 545 patients with negative initial radiographs, 62 patients (11.4%) underwent hip MRI during the emergency department visit. MRI identified 24 additional patients with hip fractures. Interobserver agreement for the presence of fracture on MRI was very good (kappa = 0.847). For patients with negative initial plain radiographs who did not have a hip MRI, follow-up did not identify any of these patients as having a subsequent diagnosis of fracture. Thus, 24/545 (4.4%; 95% CI, 3.0% to 6.5%) patients with negative initial plain radiographs had a hip fracture.	2

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14. Lubovsky O, Liebergall M, Mattan Y, Weil Y, Mosheiff R. Early diagnosis of occult hip fractures MRI versus CT scan. <i>Injury</i> 2005; 36(6):788-792.	Observational-Dx	13 patients	To compare CT and MRI in diagnosis of a painful hip in elderly patients after trauma. Accuracy, efficiency and benefits were also reported.	In Group A where all of the 6 patients underwent CT and MRI, 4 of the CT images resulted in misdiagnosis due to inaccuracy. In Group B where all the 7 patients underwent only MRI, all the results were accurate and enabled a precise and fast diagnosis. MRI was found to be a more accurate modality than CT scan for obtaining early diagnosis of occult hip fractures. These results point out the advantage of immediate MRI in patients with occult hip fracture enabling a more effective treatment, a shorter hospitalization period entailing decreased medical costs.	3
15. Bogost GA, Lizerbram EK, Crues JV, 3rd. MR imaging in evaluation of suspected hip fracture: frequency of unsuspected bone and soft-tissue injury. <i>Radiology</i> 1995; 197(1):263-267.	Review/Other-Dx	70 patients	To determine the frequency of unsuspected pelvic fracture and soft-tissue injury in patients referred for MRI for possible radiographically occult hip fracture.	80% of patients had bone or soft-tissue abnormalities. Occult femoral and pelvic fractures were demonstrated in 37% and 23% of patients, respectively. Soft-tissue abnormalities were noted in 74% of patients. When a proximal femoral fracture was not present, MRI revealed a 27% frequency of occult pelvic fracture and a 50% frequency of bone or soft-tissue abnormality.	4
16. Kirby MW, Spritzer C. Radiographic detection of hip and pelvic fractures in the emergency department. <i>AJR</i> 2010; 194(4):1054-1060.	Observational-Dx	92 patients, 97 examinations	To evaluate the detection of hip and pelvic fractures with radiography in the emergency department.	13 patients (14%) with normal radiographic findings were found to have 23 fractures at MRI (6 hip and 17 pelvic fractures). In 11 patients (12%) MRI showed no fracture after radiographic findings had suggested the presence of a fracture. In another 15 patients who had abnormal findings on radiographs, MRI depicted 12 additional pelvic fractures not identified on radiographs. In 43/59 patients (73%) without MRI evidence of a fracture, the MRI findings suggested the presence of a potential pain generator, including muscle edema and tears, trochanteric bursitis, and hamstring tendinopathy. Receiver operating characteristics analysis for the detection of hip fractures with radiography showed an area under the curve of 0.74.	3

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17. Sankey RA, Turner J, Lee J, Healy J, Gibbons CE. The use of MRI to detect occult fractures of the proximal femur: a study of 102 consecutive cases over a ten-year period. <i>J Bone Joint Surg Br</i> 2009; 91(8):1064-1068.	Review/Other-Dx	102 consecutive patients	To investigate the use of MRI in making an early diagnosis and formulating a management plan in patients with no visible fracture of the proximal femur on plain radiographs.	There were 98 patients who fulfilled our inclusion criteria, of whom 75 were scanned within 48 hours of admission, with an overall mean time between admission and scanning of 2.4 days (0 to 10). A total of 81 patients (83%) had abnormalities detected on MRI; 23 (23%) required operative management. The use of MRI led to the early diagnosis and treatment of occult hip pathology. There is a high incidence of fractures which are not apparent on plain radiographs, and shows that MRI is useful when diagnosing other pathology such as malignancy, which may not be apparent on plain films.	4
18. Sauser DD, Billimoria PE, Rouse GA, Mudge K. CT evaluation of hip trauma. <i>AJR</i> 1980; 135(2):269-274.	Review/Other-Dx	13 case reports	To compare CT and conventional radiography for evaluation of hip trauma and treatment planning.	13 patients had CT after accidents resulting in trauma to the hip and pelvis. The CT scan had significantly influenced the treatment in four of the patients and provided useful information in several others. CT was found to be helpful for evaluating the presence or absence of intra-articular osseous loose fragments after reduction of the dislocated hip. In addition, CT was helpful in evaluating congruity of the joint space after fractures of the femoral head and acetabulum. CT also provided useful information concerning the adjacent soft tissues and associated pelvic fractures.	4
19. Deutsch AL, Mink JH, Waxman AD. Occult fractures of the proximal femur: MR imaging. <i>Radiology</i> 1989; 170(1 Pt 1):113-116.	Review/Other-Dx	23 patients	To present experience with MRI in the evaluation of occult hip fracture.	MRI can provide a rapid, cost-effective, and anatomically precise diagnosis of hip fracture in patients with normal or equivocal initial radiographs. The specificity of the diagnosis achieved can obviate supplemental imaging examinations, with their attendant additional expense and radiation exposure.	4

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20. Quinn SF, McCarthy JL. Prospective evaluation of patients with suspected hip fracture and indeterminate radiographs: use of T1-weighted MR images. <i>Radiology</i> 1993; 187(2):469-471.	Observational-Dx	20 patients	To assess the diagnostic efficacy of T1-weighted MRI when findings on radiographs of the hip are indeterminate.	When MRI and clinical outcome were used as the standard of reference, the prospective accuracy of MRI in diagnosis of the presence or absence of hip fracture was 100%. All MRI studies were diagnostic. Of the 13 patients with fracture (8 with trochanteric and 5 with subcapital fracture), 10 patients (77%) underwent surgery and 3 patients (23%) received conservative treatment. T1-weighted MRI can enable diagnosis or exclusion of hip fracture whenever radiographs are indeterminate.	3
21. Verbeeten KM, Hermann KL, Hasselqvist M, et al. The advantages of MRI in the detection of occult hip fractures. <i>Eur Radiol</i> 2005; 15(1):165-169.	Observational-Dx	33 patients	Retrospective review to assess the accuracy of reading radiographs and MRIs in the detection of occult hip fractures as well as the cost advantages of utilizing MRI immediately instead of 3 days rest before subsequent radiography and/or scintigraphy.	For all 4 doctors participating in this study, MRI proved to be far more sensitive and specific in the detection of occult hip fractures than radiography. Using the MRIs, the senior radiologists identified the occult hip fracture patients with 100% accuracy and were in complete agreement. The agreement between junior and senior radiologists was high (average kappa=0.75). MRI also detected soft tissue injuries in 39% of the patients that could not be identified with radiography. Adoption of the new protocol using MRI saves hospitals from Euro 242 to 627 per patient. By shortening the time to diagnosis and permitting a superior visualization of both bone and soft tissue injuries, MRI prevents unnecessary hospitalization and delays in definitive treatment. MRIs should be assessed by senior radiologists.	3

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22. Cabarrus MC, Ambekar A, Lu Y, Link TM. MRI and CT of insufficiency fractures of the pelvis and the proximal femur. <i>AJR</i> 2008; 191(4):995-1001.	Observational-Dx	145 patients	To compare the sensitivity of CT and MRI in detecting insufficiency fractures; to analyze the typical location, morphology, and combinations thereof in these fractures; to analyze imaging morphology; and to analyze associated clinical findings.	In the subgroup undergoing both imaging techniques, MRI detected 128/129 (99%) fractures in 63/64 (98%) subjects, whereas CT detected only 89/129 (69%) fractures in 34/64 (53%) subjects. In particular, fractures at the femoral head and acetabulum were better detected with MRI. In the complete population, two or more fractures were found in 70.3% (102/145) of patients and 89.2% (33/37) of patients with pubic insufficiency fractures had concomitant fractures at other locations. In 63/145 (43.4%) patients, a previous malignancy was found; in only 93/145 (64.1%) patients, the leading symptom responsible for the MRI examination was pain.	3
23. Dunker D, Collin D, Gothlin JH, Geijer M. High clinical utility of computed tomography compared to radiography in elderly patients with occult hip fracture after low-energy trauma. <i>Emerg Radiol</i> 2012; 19(2):135-139.	Observational-Dx	193 hip CT examinations	To evaluate the clinical utility of CT compared to radiography in evaluating suspect or missed hip fractures in elderly after low-energy trauma.	84 examinations revealed no fracture. Follow-up was uneventful but for 2 patients who had been operated. 39/41 cervical hip fractures were surgically or otherwise confirmed, 2 cases were not operated due to week-old trauma and moderate symptoms. 29/68 trochanteric fractures or avulsions were confirmed surgically. CT has a high clinical utility as it can detect nearly all clinically suspect but radiographically negative cervical hip fractures as well as most trochanteric fractures and avulsions. A negative CT is near-perfect in ruling out a hip fracture requiring surgery.	3
24. Geijer M, Dunker D, Collin D, Gothlin JH. Bone bruise, lipohearthrosis, and joint effusion in CT of non-displaced hip fracture. <i>Acta Radiol</i> 2012; 53(2):197-202.	Observational-Dx	231 hip low-energy trauma cases	To assess the frequency and clinical utility of non-cortical skeletal and soft tissue lesions as ancillary fracture signs in CT diagnosis of occult hip fractures.	There were no fracture signs in 110 patients. 12 of these had a joint effusion. In 121 patients with 46 cervical hip fractures and 75 trochanteric fractures one or more fracture signs were present. Cortical fractures were found in 115 patients. Bone bruise was found in 119 patients, joint effusion in 35, and lipohearthrosis in 20 patients.	4

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25. Collin D, Dunker D, Gothlin JH, Geijer M. Observer variation for radiography, computed tomography, and magnetic resonance imaging of occult hip fractures. <i>Acta Radiol</i> 2011; 52(8):871-874.	Observational-Dx	375 patients, 3 observers	To assess observer variation in radiography, CT and MRI of suspected occult, non-displaced hip fractures, and to evaluate to what extent observer experience or patient age may influence observer performance.	For radiography, agreements between the three observers were moderate to substantial for intracapsular fractures, with kappa values in the ranges of 0.56-0.66. Kappa values were substantial for extracapsular fractures, in the ranges of 0.69-0.72. With increasing professional experience, fewer fractures were classified as equivocal at radiography. For CT and MRI, observer agreements were similar and almost perfect, with kappa values in the ranges of 0.85-0.97 and 0.93-0.97.	2
26. Haramati N, Staron RB, Barax C, Feldman F. Magnetic resonance imaging of occult fractures of the proximal femur. <i>Skeletal Radiol</i> 1994; 23(1):19-22.	Review/Other-Dx	15 patients	To present authors' experience using MRI as the sole imaging examination in cases of suspected hip fracture in osteopenic patients with normal plain radiographs.	A clear fracture was seen in 10/15 patients, who then underwent surgical repair based on the MR study. The remaining patients had no MR-demonstrable fracture and were successfully treated nonoperatively. 2/15 patients had MR-demonstrated bone infarcts near the fracture. One patient also had femoral head osteonecrosis on the side of the fracture. One patient with metastatic prostatic carcinoma had a hip fracture and one patient with metastatic breast carcinoma had no fracture. Not only is MRI an excellent technique for delineating occult fractures, but due to its spatial resolution, associated bone disorders adjacent to fractures can be detected in most instances. From a cost perspective, rapid diagnosis and early treatment of an occult femoral fracture is advisable. A reduced hospital stay pending diagnosis and the early institution of definitive therapy also decrease the chance that a simple non-displaced fracture will displace and require more complex management with resultant increased morbidity and cost.	4

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27. Pandey R, McNally E, Ali A, Bulstrode C. The role of MRI in the diagnosis of occult hip fractures. <i>Injury</i> 1998; 29(1):61-63.	Review/Other-Dx	33 patients	To assess the role of MRI in the diagnosis of occult hip fractures.	MRI scans were done on 33 patients who had post-traumatic painful hips but negative radiographs. 40% of the patients had sustained a fractured neck of femur, 15% had sustained an intertrochanteric fracture and 11% had sustained other fractures around the hip; in one patient a tumor was demonstrated. No fracture was seen in 30% of the patients scanned. MRI is well tolerated by elderly patients in pain, does not involve ionizing radiation and provides early and accurate diagnosis in patients with X-ray negative post-traumatic hip pain.	4
28. Schultz E, Miller TT, Boruchov SD, Schmell EB, Toledano B. Incomplete intertrochanteric fractures: imaging features and clinical management. <i>Radiology</i> 1999; 211(1):237-240.	Review/Other-Dx	31 patients	To present the imaging findings and treatment options for incomplete intertrochanteric fractures.	The correlation between radiographic and MR findings was poor. Incomplete intertrochanteric fracture was the prospective radiographic diagnosis in only one case. Fracture in 18 patients was treated surgically and in 13 was managed conservatively. In both groups, the average age of the patients and length of the fractures and the percentage of separate fractures involving the greater trochanter and crossing the midline of the femur in the axial plane were the same. Fractures crossed the midline in the coronal plane in 50% of the surgical group but in only 23% of the nonsurgical group. Average time from injury to ambulation was 2 days less in the surgical group, but no difference in functional status was found subjectively between the two groups at clinical follow-up.	4

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29. Alam A, Willett K, Ostlere S. The MRI diagnosis and management of incomplete intertrochanteric fractures of the femur. <i>J Bone Joint Surg Br</i> 2005; 87(9):1253-1255.	Observational-Dx	68 patients	To establish whether incomplete intertrochanteric fractures can be successfully managed conservatively.	A hip fracture was suspected in 18 patients despite normal plain radiographs; these patients were subsequently found to have a fracture of the femoral neck (10 intracapsular, 8 intertrochanteric). The 8 patients with an intertrochanteric fracture (5 men, 3 women) did not have shortening of the lower limb, or an external rotation deformity on examination. 3 patients, with a mean age of 61 years (standard deviation 5.6) were managed with a dynamic hip screw and 5 patients, with a mean age of 73.4 (standard deviation 17.2) were considered to be a high anesthetic risk and were, therefore, treated conservatively. The mean length of hospital stay in the conservatively-treated group was 16 days (standard deviation 4.2) but 15 days (standard deviation 3.0) for those treated with surgery; this was not statistically significant (P>0.5). All patients were mobilized with walking support on discharge. One patient developed a wound haematoma, which was the only known surgical complication in this group. No patient who had been treated conservatively was readmitted for a complete fracture although 5 were readmitted for unrelated reasons (2 operative, 3 nonoperative). The mean time of readmission after fracture was 3.2 years (2 to 5) although all 5 patients had been mobilizing independently, with walking support, by the time of their readmission.	4
30. Lee YP, Griffith JF, Antonio GE, Tang N, Leung KS. Early magnetic resonance imaging of radiographically occult osteoporotic fractures of the femoral neck. <i>Hong Kong Med J</i> 2004; 10(4):271-275.	Review/Other-Dx	28 patients	To review experiences of early MRI performed within 48 hours of presentation to hospital.	28 patients (age range, 69-93 years) over a 3-year period were studied. MRI revealed radiographically occult neck fractures in 14 (50%) cases (equivalent to 4% of all femoral neck fractures). These fractures were treated surgically (64%) or conservatively (36%) with good bone healing and clinical outcome. When no femoral neck fracture was present, MRI revealed an alternative cause for symptoms in all 14 cases.	4

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31. Bottle A, Aylin P. Mortality associated with delay in operation after hip fracture: observational study. <i>BMJ</i> 2006; 332(7547):947-951.	Observational-Dx	129 522 admissions, 151 trusts	To estimate the number of deaths and readmissions associated with delay in operation after femoral fracture.	There were 129,522 admissions for fractured neck of femur in 151 trusts with 18,508 deaths in hospital (14.3%). Delay in operation was associated with an increased risk of death in hospital, which was reduced but persisted after adjustment for comorbidity. For all deaths in hospital, the OR for more than one day's delay relative to one day or less was 1.27 (95% CI, 1.23 to 1.32) after adjustment for comorbidity. The proportion with more than two days' delay ranged from 1.1% to 62.4% between trusts. If death rates in patients with at most one day's delay had been repeated throughout all 151 trusts in this study, there would have been an average of 581 (478 to 683) fewer total deaths per year (9.4% of the total). There was little evidence of an association between delay and emergency readmission.	4
32. Bergeron E, Lavoie A, Moore L, et al. Is the delay to surgery for isolated hip fracture predictive of outcome in efficient systems? <i>J Trauma</i> 2006; 60(4):753-757.	Observational-Dx	977 patients	To identify the causes and outcome of delay for hip surgery in an efficient system.	Overall mortality was 12.2%. Surgery was performed within 24 hours in 53% of cases and within 48 hours in 87% of cases. The presence of comorbidity partly explained longer (>48 hours) surgical delays. Multivariate analysis revealed that age greater than 65, male sex, and the presence of pulmonary and cardiac comorbid conditions or an active cancer but not surgical delay were associated with mortality and complications. However, surgical delay was associated with longer postsurgical hospital stay, independently of the presence of comorbidity or increasing age.	4

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33. Novack V, Jotkowitz A, Etzion O, Porath A. Does delay in surgery after hip fracture lead to worse outcomes? A multicenter survey. <i>Int J Qual Health Care</i> 2007; 19(3):170-176.	Observational-Dx	4,633 patients	To estimate the impact of delays in surgery for hip fracture on short- and long-term outcomes.	Study population comprises 4,633 patients, >65 years. The conservative approach was chosen in 818 patients (17.7%), while 1,350 patients (29.1%) waited >2 days from admission to the surgery. There was a substantial variation in median preoperative stay among the hospitals (range 0-4 days). Patients who had surgery within 2 days had lower mortality (in-hospital, 1-month and 1-year) compared to those who waited for surgery >4 days (2.9%, 4.0%, 17.4% vs 4.6%, 6.1%, 26.2%, respectively). A Cox proportional regression model of 1-year mortality in operated patients adjusted for background morbidity (Charlson index) showed that the length of operation delay has a gradual effect on increasing mortality (<2 days-reference group, 2-4 days-OR = 1.20, 5 days or longer, OR=1.50). The 818 (17.7%) nonoperated patients suffered the highest 1-year mortality, 36.2%.	4
34. Lefavre KA, Macadam SA, Davidson DJ, Gandhi R, Chan H, Broekhuysen HM. Length of stay, mortality, morbidity and delay to surgery in hip fractures. <i>J Bone Joint Surg Br</i> 2009; 91(7):922-927.	Observational-Dx	607 patients	To determine the effect of delay to surgery on the time to discharge, in-hospital death, the presence of major and minor medical complications and the incidence of pressure sores in patients with a fracture of the hip.	Delay to surgery (P=0.0255), comorbidity (P<0.0001), age (P<0.0001) and type of fracture (P=0.0004) were all significant in the Cox proportional hazards model for increased time to discharge. Delay to surgery was not a significant predictor of in-hospital mortality. However, a delay of more than 24 hours was a significant predictor of a minor medical complication (OR 1.53, 95% CI, 1.05 to 2.22), while a delay of more than 48 hours was associated with an increased risk of a major medical complication (OR 2.21, 95% CI, 1.01 to 4.34), a minor medical complication (OR 2.27, 95% CI, 1.38 to 3.72) and of pressure sores (OR 2.29, 95% CI, 1.19 to 4.40). Patients with a fracture of the hip should have surgery early to lessen the time to acute-care hospital discharge and to minimize the risk of complications.	4

**Acute Hip Pain — Suspected Fracture
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
35. Khan SK, Kalra S, Khanna A, Thiruvengada MM, Parker MJ. Timing of surgery for hip fractures: a systematic review of 52 published studies involving 291,413 patients. <i>Injury</i> 2009; 40(7):692-697.	Review/Other-Dx	52 studies involving 291,413 patients	To review previous published studies on hip fractures with the aim of developing a consensus from the literature for the optimum timing for surgery for an acute hip fracture.	Delaying surgery may not affect mortality but it is likely to increase morbidity, specifically the incidence of pressure sores and hospital stay. Delaying surgery will prolong distress from this type of injury, therefore, patients admitted to a hospital with a hip fracture, where there are no specific conditions that can be improved prior to surgery, should have their operation as soon as possible after admission (within 48 hours) to a hospital.	4
36. Rubin SJ, Marquardt JD, Gottlieb RH, Meyers SP, Totterman SM, O'Mara RE. Magnetic resonance imaging: a cost-effective alternative to bone scintigraphy in the evaluation of patients with suspected hip fractures. <i>Skeletal Radiol</i> 1998; 27(4):199-204.	Review/Other-Dx	40 patients	To evaluate the cost-effectiveness of MRI compared with radionuclide bone scan in the evaluation of patients with clinically suspected hip fractures.	21 patients had bone scans (6 with fractures), and 19 had MRI (4 with fractures). The time to diagnosis was 2.24 +/- 1.30 days for bone scanning and 0.368 +/- 0.597 days for MRI (P<0.0001). 20 patients in the bone scan group were admitted compared with 13 in the MRI group. The time to surgery was at least 1 day longer in patients undergoing bone scanning. Bone scanning resulted in higher patient costs compared with MRI because of the delay in diagnosis. In the evaluation of patients with suspected hip fractures, early MRI is more cost-effective than delayed bone scanning.	4
37. Dy CJ, McCollister KE, Lubarsky DA, Lane JM. An economic evaluation of a systems-based strategy to expedite surgical treatment of hip fractures. <i>J Bone Joint Surg Am</i> 2011; 93(14):1326-1334.	Review/Other-Dx	N/A	To determine the cost-effectiveness of a hypothetical scenario in which resources are allocated to expedite surgery so that it is performed within 48-hours after admission.	The evaluation-focused strategy was cost-effective, with an incremental cost-effectiveness ratio of \$2318 per QALY, and became cost-saving (a dominant therapeutic approach) if =93% of patients underwent expedited surgery, the hourly cost of retaining a diagnostic technologist on call was <\$20.80, or <15% of the hospitalist's salary was funded by the strategy. The second strategy, which added an on-call surgical team, was also cost-effective, with an incremental cost-effectiveness ratio of \$43,153 per QALY. Sensitivity analysis revealed that this strategy remained cost-effective if the OR of one-year mortality associated with delayed surgery was >1.28, =88% of patients underwent early surgery, or =339.9 patients with a hip fracture were treated annually.	4

**Acute Hip Pain — Suspected Fracture
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
38. Lim KB, Eng AK, Chng SM, Tan AG, Thoo FL, Low CO. Limited magnetic resonance imaging (MRI) and the occult hip fracture. <i>Ann Acad Med Singapore</i> 2002; 31(5):607-610.	Review/Other-Dx	422 patients	To examine the diagnosis of hip fracture by utilizing limited MRI.	Limited MRI of the hip in this group of 57 patients confirmed that 8 (14%) sustained a femoral neck fracture, while 5 (9%) had an intertrochanteric fracture. In 19 patients (33%), some other pathology was found, mainly stable fractures of the femoral trochanters and pubic rami. Overall, 32 scans (56%) were positive and 25 (44%) were negative. Limited MRI detected patients with undisplaced hip fractures and identified them as candidates for surgery.	4
39. Lang P, Mauz M, Schorner W, et al. Acute fracture of the femoral neck: assessment of femoral head perfusion with gadopentetate dimeglumine-enhanced MR imaging. <i>AJR</i> 1993; 160(2):335-341.	Review/Other-Dx	13 patients	To evaluate the use of MRI, before and after intravenous administration of gadopentetate dimeglumine, for assessing perfusion of the femoral head in 13 patients with acute fracture of the femoral neck.	Digital subtraction angiography showed impaired blood supply to the femoral head in 5 patients. On contrast-enhanced MRIs of these patients, the femoral head did not enhance and was lower in signal intensity than were the enhancing femoral shaft and neck distal to the fracture and the enhancing femoral head on the unaffected side. In the patients with persistent perfusion, contrast-enhanced MRIs showed a uniform increase in signal intensity in the femoral shaft and neck as well as the femoral head; the femoral head on the fractured side showed contrast enhancement similar to that on the healthy side.	4
40. Konishiike T, Makihata E, Tago H, Sato T, Inoue H. Acute fracture of the neck of the femur. An assessment of perfusion of the head by dynamic MRI. <i>J Bone Joint Surg Br</i> 1999; 81(4):596-599.	Review/Other-Dx	22 patients, 20 control subjects	To use dynamic MRI for the assessment of perfusion of the femoral head in 22 patients and compare the signal-intensity curve (dynamic curve) in the head on the fractured side with that of the opposite, normal head and of 20 control subjects.	3 MRI patterns emerged when the results between the fractured side and the contralateral femoral head were compared. In the entire control group and in those patients who had undisplaced fractures (Garden stages I and II), perfusion of the femoral head was considered to be at the same level as on the unaffected side. In patients with displaced fractures (Garden stages III and IV) almost all the femoral heads on the fractured side were impaired or totally avascular, although some had the same level of perfusion as the unaffected side. Dynamic MRI, a new non-invasive imaging technique, is useful for evaluating the perfusion of the femoral head.	4

**Acute Hip Pain — Suspected Fracture
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
41. Hirata T, Konishiike T, Kawai A, Sato T, Inoue H. Dynamic magnetic resonance imaging of femoral head perfusion in femoral neck fracture. <i>Clin Orthop Relat Res</i> 2001; (393):294-301.	Observational-Dx	36 femoral neck fractures	Prospective follow-up study of femoral neck fractures according to the assessment of femoral head perfusion using dynamic MRI.	Patients were divided into three groups based on the dynamic MRI findings (dynamic curve pattern and relative enhancement ratio) that were conducted within 48 hours of the injury. Traction was used to achieve anatomic reduction and to prevent additional damage to vascularity until minimally invasive internal fixation could be done. The fractures of all 17 patients whose femoral head perfusion was normal (Type A; n=11) or was impaired but not totally absent (Type B; n=6) healed without complications. Among the 19 patients whose femoral head perfusion was absent (Type C), 15 had complications (osteonecrosis, n=10; nonunion, n=5). Assuming that fractures with a Type A or Type B curve pattern would unite successfully and that those with a Type C curve pattern would not, the sensitivity, specificity, and accuracy of the predictions of successful osteosynthesis of the femoral neck fractures using this method were 81%, 100%, and 89%, respectively.	3

**Acute Hip Pain — Suspected Fracture
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Kaushik A, Sankaran B, Varghese M. Prognostic value of dynamic MRI in assessing post-traumatic femoral head vascularity. <i>Skeletal Radiol</i> 2009; 38(6):565-569.	Observational-Dx	30 patients with 31 hips	To evaluate the role of dynamic MRI in predicting femoral head vascularity and thereby avascular necrosis after intracapsular femoral neck fractures.	Fractures were divided into 3 types (Type A, B, or C) based on the femoral head vascularity shown by dynamic curve patterns on MRI evaluation. Type A was preserved vascularity, Type B was some decrease in vascularity but still viable while Type C was significantly reduced vascularity. Type A curves correlate well with vascular status and Type C curves correlate well with poor vascularity of the femoral heads. No avascular necrosis was seen in any of Type A (13/31) or Type B (eight out of 31). 5 cases showed avascular necrosis and all of them were of Type C dynamic curves. Dynamic MRI is a reliable tool to evaluate vascularity of femoral heads and thus reduces the uncertainty of outcome of treatment of intracapsular femoral neck fractures. Dynamic MRI can be a useful tool to formulate a treatment algorithm in management of intracapsular femoral neck fracture.	3
43. Henes FO, Nuchtern JV, Groth M, et al. Comparison of diagnostic accuracy of Magnetic Resonance Imaging and Multidetector Computed Tomography in the detection of pelvic fractures. <i>Eur J Radiol</i> 2011.	Observational-Dx	38 patients	To compare diagnostic accuracy and interobserver reliability of MRI and multidetector CT in the detection of acute pelvic fractures.	122 fractures were identified in the reference standard (37 sacral, 58 pubic, 22 acetabular, 1 ischial, 4 ilial). On average, MRI detected 96.3% whereas CT detected 77% of all fractures. With regard to sensitivity, MRI proved to be significantly better compared to multidetector CT (observer 1, P=0.0009; observer 2, P=0.0003 by observer 2). In particular, MRI performed better in the depiction of sacral fractures, reaching a sensitivity of 98.6% compared to 66.1% at CT. The interobserver variability was determined to be very good (k=0.955 for MRI and 0.902 for multidetector CT).	2
44. Safran O, Goldman V, Applbaum Y, et al. Posttraumatic painful hip: sonography as a screening test for occult hip fractures. <i>J Ultrasound Med</i> 2009; 28(11):1447-1452.	Observational-Dx	30 patients	To evaluate sonography as a screening tool for occult hip fractures in posttraumatic painful hips in elderly patients.	10 hip fractures were diagnosed by MRI. Sonography showed trauma-related changes in all of those patients and in 7 additional patients, 3 of whom had pubic fractures. Sonography correctly identified 13 patients without hip fractures. The sensitivity of sonography was found to be 100%, whereas the specificity for hip fractures was 65%.	2

* See Last Page for Key

Acute Hip Pain — Suspected Fracture
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
45. Carnevale V, Frusciante V, Scillitani A, et al. Age-related changes in the global skeletal uptake of technetium-99m methylene diphosphonate in healthy women. <i>Eur J Nucl Med</i> 1996; 23(11):1473-1477.	Observational-Dx	40 patients	To investigate the clinical performance of global skeletal uptake of Tc-99m methylene diphosphonate and to detect the age-related changes in bone turnover.	Results were compared with measurements of the main biochemical markers of skeletal metabolism. Global skeletal uptake increases progressively with age, independently of concomitant changes in renal function; significant correlations with biochemical markers of bone formation were also found. The method appears to provide useful information concerning the bone turnover rate, and is also applicable to elderly people owing to its simplicity.	3
46. NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, March 7-29, 2000: highlights of the conference. <i>South Med J</i> 2001; 94(6):569-573.	Review/Other-Dx	N/A	Conference held to discuss osteoporosis prevention, diagnosis, and therapy.	Results not stated in abstract.	4
47. American College of Radiology. ACR–SSR Practice Guideline for the Performance of Dual-Energy X-Ray Absorptiometry (DXA). http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/dx/musc/dxa.aspx . Accessed 30 April 2012.	Review/Other-Dx	N/A	N/A	Results not stated in abstract.	4
48. American College of Radiology. <i>Manual on Contrast Media</i> . Available at: http://www.acr.org/~link.aspx?_id=29C40D1FE0EC4E5EAB6861BD213793E5&_z=z .	Review/Other	N/A	Guidance document on contrast media to assist radiologists in recognizing and managing risks associated with the use of contrast media.	N/A	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
 - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
 - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
 - c) the study is an expert opinion or consensus document.

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

CI = Confidence interval

CT = Computed tomography

MRI = Magnetic resonance imaging

OR = Odds ratio

QALY = Quality-adjusted life-years