

Avascular Necrosis (Osteonecrosis) of the Hip
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Lavernia CJ, Sierra RJ, Grieco FR. Osteonecrosis of the femoral head. <i>J Am Acad Orthop Surg</i> 1999; 7(4):250-261.	12	N/A	Review osteonecrosis of the femoral head.	Osteonecrosis of the femoral head has been associated with corticosteroid use, substance abuse, and various systemic medical conditions. Most cases are diagnosed in an advanced stage of disease, when minimally invasive surgical procedures are not helpful.	4
2. Beltran J, Opsha O. MR imaging of the hip: osseous lesions. <i>Magn Reson Imaging Clin N Am</i> 2005; 13(4):665-676, vi.	12	N/A	Qualitative review of use of MRI.	Hip trauma and avascular necrosis (AVN) are the most frequent indications for MRI. Other entities for which MRI has proven its usefulness include subchondral fractures, osteochondritis dissecans, transient osteoporosis, bone tumors, inflammatory and infectious processes, and a variety of bone marrow disorders.	4
3. Demant AW, Kocovic L, Henschkowski J, et al. Hip pain in renal transplant recipients: symptomatic gluteus minimus and gluteus medius tendon abnormality as an alternative MRI diagnosis to avascular necrosis. <i>AJR</i> 2007; 188(2):515-519.	13	24	To review the diagnosis on MRI and radiography of patients with hip pain and to determine whether an association exists between kidney transplant patients with end-stage renal disease and symptomatic gluteus minimus and medius tendon abnormality.	Symptomatic gluteus minimus and medius tendon lesions and abnormalities can occur in renal allograft recipients. The MRI findings of this entity allow an alternative diagnosis in this patient population.	3
4. Hauzeur JP, Pasteels JL, Schoutens A, et al. The diagnostic value of magnetic resonance imaging in non-traumatic osteonecrosis of the femoral head. <i>J Bone Joint Surg Am</i> 1989; 71(5):641-649.	9	25	Compare radiographs, CT, bone scans, and MRI with bone biopsies in suspected AVN to examine the value of nuclear MRI.	MRI detected all cases of AVN and was superior to bone scanning, CT, and radiographs.	3
5. Stevens K, Tao C, Lee SU, et al. Subchondral fractures in osteonecrosis of the femoral head: comparison of radiography, CT, and MR imaging. <i>AJR</i> 2003; 180(2):363-368.	9	45	Multicenter clinical trial to compare the sensitivity of unenhanced radiography, CT, and MRI in revealing subchondral fractures.	CT reveals more subchondral fractures in osteonecrosis of the femoral head than unenhanced radiography or MRI. Compared with CT, MRI has a sensitivity and specificity of 38% and 100%, and unenhanced radiography has a sensitivity and specificity of 71% and 97%, respectively.	2
6. Hsieh MS, Tsai MD, Yeh YD. Three-dimensional hip morphology analysis using CT transverse sections to automate diagnoses and surgery managements. <i>Comput Biol Med</i> 2005; 35(4):347-371.	13	N/A	To describe an image analysis method that evaluates bone morphology of hip structures including the femur stem, trochanter, neck and head, acetabulum, and pelvis to automate hip diagnoses and surgical managements.	Method can be used to accurately diagnose hip diseases and manage hip surgeries, and train operators.	4
7. Theodorou DJ, Malizos KN, Beris AE, Theodorou SJ, Soucacos PN. Multimodal imaging quantitation of the lesion size in osteonecrosis of the femoral head. <i>Clin Orthop Relat Res</i> 2001; (386):54-63.	9	45 patients 77 hips	Patients with osteonecrosis of the femoral head were evaluated using a multimodal imaging approach that included conventional radiography, bone scintigraphy, and MRI.	Conventional radiography closely approximated measurements of the lesion size obtained by MRI. Bone scintigraphy and MRI were well suited for detection of osteonecrosis at an early stage.	2

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8. Ryu JS, Kim JS, Moon DH, et al. Bone SPECT is more sensitive than MRI in the detection of early osteonecrosis of the femoral head after renal transplantation. <i>J Nucl Med</i> 2002; 43(8):1006-1011.	9	24 patients 32 femoral heads	Compared the diagnostic sensitivity of Tc-99m-methylene diphosphonate bone SPECT and MRI in the early detection of femoral head osteonecrosis after renal transplantation.	Tc-99m-methylene diphosphonate SPECT is more sensitive (100%) than MRI (66%) for the detection of femoral head osteonecrosis in renal transplant recipients. Bone scintigraphy with SPECT is needed to diagnose osteonecrosis in patients with hip pain despite normal radiography results after renal transplantation.	2
9. Scheiber C, Meyer ME, Dumitresco B, et al. The pitfalls of planar three-phase bone scintigraphy in nontraumatic hip avascular osteonecrosis. <i>Clin Nucl Med</i> 1999; 24(7):488-494.	9	120 patients with nontraumatic hip pain 23 patients – control group 6 observers	Documented the previously reported lower sensitivity of routine planar three-phase bone scintigraphy performed using a high-resolution parallel-hole collimator compared with MRI to diagnose nontraumatic AVN.	Patients had a standard radiograph and MRI within 2 months of the bone scintigraphy. Bone scintigraphy is not indicated to diagnose possible contralateral AVN if the hip is asymptomatic.	2
10. Balakrishnan A, Schemitsch EH, Pearce D, McKee MD. Distinguishing transient osteoporosis of the hip from avascular necrosis. <i>Can J Surg</i> 2003; 46(3):187-192.	13	10 patients 12 hips	Retrospective study. Review the circumstances surrounding the misdiagnosis of transient osteoporosis of the hip AVN and to increase physician awareness of the prevalence and diagnosis of this condition in young men.	MRI appearance still misinterpreted. Symptoms may be severe but resolve over time with reduced weight bearing. The absence of focal changes on MRI is highly suggestive of a transient lesion.	3
11. Kim YM, Oh HC, Kim HJ. The pattern of bone marrow oedema on MRI in osteonecrosis of the femoral head. <i>J Bone Joint Surg Br</i> 2000; 82(6):837-841.	13	200	To assess MRI of patients with osteonecrosis of the femoral head in respect of the bone marrow oedema pattern.	The initial abnormal finding detected on the MRI was an abnormal band of intensity at the junction between the necrotic area and the normal bone.	2
12. Malizos KN, Zibis AH, Dailiana Z, Hantes M, Karachalios T, Karantanas AH. MR imaging findings in transient osteoporosis of the hip. <i>Eur J Radiol</i> 2004; 50(3):238-244.	13	42	Retrospective study to describe the MRI findings including perfusion imaging, in association with the course of acute bone marrow oedema syndrome in patients with transient osteoporosis of the hip.	Osteopenia was present on radiographs in 87% of cases. MRI pattern varies and is most commonly appearing on radiographs as osteopenia.	3
13. Vande Berg BC, Malghem JJ, Lecouvet FE, Jamart J, Maldaque BE. Idiopathic bone marrow edema lesions of the femoral head: predictive value of MR imaging findings. <i>Radiology</i> 1999; 212(2):527-535.	9	67 patients 72 femoral head lesions	Review MRI images to determine the frequency of several subchondral MRI features observed in bone marrow edema lesions of the femoral head and to determine their value for differentiation of irreversible from transient lesions.	T2-weighted or contrast-enhanced T1-weighted images had PPV of 100% for transient lesions. Irreversible lesions, 4 mm thick or 12.5 mm long had PPV of 85% and 73%, respectively, on T2-weighted images and 87% and 86%, respectively, on contrast-enhanced T1-weighted images.	3
14. Khanna AJ, Yoon TR, Mont MA, Hungerford DS, Bluemke DA. Femoral head osteonecrosis: detection and grading by using a rapid MR imaging protocol. <i>Radiology</i> 2000; 217(1):188-192.	10	92 patients 179 hips	Prospective study to design and evaluate a limited MRI exam that can be performed rapidly and potentially inexpensively in patients with clinical suspicion of osteonecrosis.	Agreement between the limited and full examinations for presence of osteonecrosis was 98.9%.	2

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15. May DA, Disler DG. Screening for avascular necrosis of the hip with rapid MRI: preliminary experience. <i>J Comput Assist Tomogr</i> 2000; 24(2):284-287.	9	12	Compare rapidly acquired MRI with routinely employed spine echo (SE) and turbo SE (TSE) images in screening for AVN.	Rapidly acquired MRI sequences that we studied reliably revealed the presence or absence of AVN, marrow edema, and osteoarthritis of the hip in our sample population when compared with SE and TSE sequences that we routinely perform.	3
16. Winzenrieth R, Claude I, Hobatho MC, Sebag G. Is there functional vascular information in anatomical MR sequences? A preliminary in vivo study. <i>IEEE Trans Biomed Eng</i> 2006; 53(6):1190-1195.	15 (feasibility study)	N/A	To determine if vascular information in dynamic MRI sequences already exists in anatomical MRI sequences in a case of Legg-Calvé-Perthes disease.	Dynamic vascular image and intrinsic anatomical image characteristics are correlated. Disease can be evaluated with objective parameters using only anatomical sequences.	3
17. Ha YC, Jung WH, Kim JR, Seong NH, Kim SY, Koo KH. Prediction of collapse in femoral head osteonecrosis: a modified Kerboul method with use of magnetic resonance images. <i>J Bone Joint Surg Am</i> 2006; 88 Suppl 3:35-40.	8	33 patients 37 hips	To determine whether the combined necrotic angle measurement from MRI scans predicts the subsequent risk of collapse in hips with femoral head necrosis.	The Kerboul combined necrotic angle, as ascertained with MRI scans instead of radiographs is a good method to assess future collapse in hips with femoral head osteonecrosis.	1
18. Nishii T, Sugano N, Ohzono K, Sakai T, Sato Y, Yoshikawa H. Significance of lesion size and location in the prediction of collapse of osteonecrosis of the femoral head: a new three-dimensional quantification using magnetic resonance imaging. <i>J Orthop Res</i> 2002; 20(1):130-136.	13	65 hips 47 patients	To examine the significance of lesion size and location in the prediction of collapse of osteonecrosis of the femoral head using new 3D indexes.	Quantitative analysis of lesion morphology demonstrated that lesion volume is strongly correlated with risk of collapse, and that lesion location is an important prognostic indicator of collapse in small necrotic lesions.	2
19. Aigner N, Schneider W, Eberl V, Knahr K. Core decompression in early stages of femoral head osteonecrosis--an MRI-controlled study. <i>Int Orthop</i> 2002; 26(1):31-35.	13	45 hips	Examine hips treated with idiopathic necrosis of the femoral head stages I-III with core decompression in MRI controlled study.	<ul style="list-style-type: none"> • For 30 hip joints in stage I, 29 showed no radiographic progression and a complete remission of the changes consistent with necrosis on MRI at the last follow-up. • For 27 patients, the clinical result based on the Harris Hip Score (HHS) assessment was excellent. • For 9 hips in stage II, 4 had received a total hip arthroplasty, one had deteriorated to stage IV, and 4 were still classified as stage II (average HHS 95 points). • For 6 hips in stage III, 3 had received a total hip arthroplasty and 3 had deteriorated to stage IV. 	2

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20. Yoshida T, Kanayama Y, Okamura M, Negoro N, Inoue T, Yoshikawa J. Long-term observation of avascular necrosis of the femoral head in systemic lupus erythematosus: an MRI study. <i>Clin Exp Rheumatol</i> 2002; 20(4):525-530.	15	13 patients 24 hips	To assess long-term prognosis of clinically silent, early-stage AVN of the femoral head in patients with systemic lupus erythematosus (SLE).	Long-term prognosis of early-stage AVN of the femoral head was favorable in patients with SLE when the necrotic area was small (less than 25%).	3
21. Hernigou P, Habibi A, Bachir D, Galacteros F. The natural history of asymptomatic osteonecrosis of the femoral head in adults with sickle cell disease. <i>J Bone Joint Surg Am</i> 2006; 88(12):2565-2572.	13	121	Study on the natural history of asymptomatic osteonecrosis of the femoral head in adults with sickle cell disease.	Untreated asymptomatic osteonecrosis of the femoral head in patients with sickle cell disease has a high possibility of developing to pain and collapse.	2
22. Nagasawa K, Tada Y, Koarada S, et al. Very early development of steroid-associated osteonecrosis of femoral head in systemic lupus erythematosus: prospective study by MRI. <i>Lupus</i> 2005; 14(5):385-390.	13	45	Prospective study to determine the early development of corticosteroid-induced osteonecrosis of femoral head in patients with SLE and to identify the association of initial steroid treatment with the development of early (silent) ONF.	Pathological osteonecrosis of femoral head develops early in 1/3 of SLE patients. High dose corticosteroids caused elevation of serum levels of total cholesterol, albumin, and leukocyte count in most of patients. The degree of elevation of those parameters at 1-3 months was more prominent in the silent ONF group. In particular, the change ratio of total cholesterol at 1 month was outstanding in the silent ONF group compared to non-ONF group (0.551 vs 0.374).	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.