Radiology. 2002 Jan;222(1):184-8.

Clinical outcome of edema-like bone marrow abnormalities of the foot.

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Abstract

PURPOSE: To evaluate the clinical outcome of edema-like bone marrow abnormalities seen on magnetic resonance (MR) images of the foot when their cause is unknown.

MATERIALS AND METHODS: The clinical outcome of 31 patients (15 female patients, 16 male patients; mean age, 51; range, 10-79 years) with edema-like bone marrow abnormalities on MR images of the foot was determined. The relevance of three different edema patterns was compared: (a) exclusively ill-defined edema-like zones, (b) edema-like zones plus well-defined necrosis-like zones, and (c) edema-like zones plus linear structures indicating possible fractures. The different edema patterns were compared with persistence of pain.

RESULTS: Fifty-four percent of all patients had pain persisting after 1 year, as calculated with the Kaplan-Meier method. The duration of pain in the various subgroups varied significantly (P =.049, log-rank test). The subgroup of patients with a well-defined necrosis-like zone had substantially longer-lasting pain than those with edema-like abnormalities only (n = 16) (P =.065). Only one of seven patients with a well-defined necrosis-like zone (n = 7) was pain free after 1 year. Conversely, patients with possible stress fracture (n = 8) had shorter pain compared with those with edema-like abnormalities only (P =.036); six of eight patients were pain free after 1 year.

CONCLUSION: Edema-like bone marrow abnormalities of the foot predict long-lasting pain. Analysis of the image patterns of such abnormalities allows prediction of the clinical outcome to a certain degree.

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Am J Roentgenol

AJR Am J Roentgenol. 2003 Aug;181(2):545-9.

MR imaging of bone marrow edema and joint effusion in patients with osteonecrosis of the femoral head: relationship to pain.

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Abstract

OBJECTIVE: Our aim was to determine the occurrence of bone marrow edema and joint effusion and their relationship to pain in patients with osteonecrosis of the femoral head on the basis of MR imaging.

MATERIALS AND METHODS: There were 71 patients with osteonecrosis of the femoral head based on characteristic radiographic and MR imaging findings. All patients had surgical confirmation of the disease. Both hips were affected with osteonecrosis in 39 patients, whereas only one hip was involved in 31 patients. The last patient underwent an arthroplasty of one hip during the study and had only one hip imaged. We evaluated a total of 110 hips in this study, of which 98 were painful. We staged osteonecrosis of the femoral head, using the classification of Steinberg et al. The 31 unaffected hips served as controls. Bone marrow edema and joint fluid were evaluated on MR images. Bone marrow edema was defined as an ill-defined area of low signal intensity on T1-weighted images with corresponding high signal intensity on T2-weighted or inversion recovery images localizing to the femoral head, neck, and intertrochanteric region. The amount of joint fluid was graded from 0 to 3.

RESULTS: The peak of bone marrow edema occurred in stage III disease (72%); its odds ratio was seven times greater than that for stage I osteonecrotic hips. Effusions of a grade greater than or equal to 2 were seen most often in stage III disease (92%), compared with 10% in the control hips. With an effusion, bone marrow edema was 12.6 times greater when the hip was painful than when it was not.

CONCLUSION: Both bone marrow edema and joint effusions existed with a peak occurrence in stage III disease. Bone marrow edema seems to have a stronger association with pain than does joint effusion in osteonecrosis of the femoral head.

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MeSH Terms

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Eur J Radiol. 2007 Apr;62(1):6-15. Epub 2007 Feb 20.

Bone marrow edema in sports: general concepts.

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Abstract

This paper will discuss the value of medical imaging in the detection and follow-up of bone marrow edema (BME), resulting from acute and chronic trauma in sports. MR imaging is the only imaging technique that allows direct evaluation of bone marrow edema in sports medicine. The use of fat suppressed T2-weighted or STIR images is particularly appropriate to detect bone marrow edema. The extent of bone marrow edema reflects the biomechanics of trauma. Compressive forces between two bony structures will result in extensive areas of bone marrow edema, whereas distraction forces provoke more subtle areas of bone marrow edema at the insertion of supporting structures of joints. In most clinical situations, a combination of compression and distraction forces is present, causing a complex pattern of bone marrow edema. A meticulous pattern approach of the distribution of these bone marrow changes around a joint can reveal in most instances the underlying mechanism of trauma. This may be helpful to analyze which joint supporting structures may be at risk. In the acute setting, plain radiography and CT scan may have an additional role in the detection of small avulsion fractures occurring at the site of minor areas of bone marrow edema. The clinical significance and natural history of bone marrow edema is still a matter of debate.

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Radiology. 1996 Mar;198(3):851-3.

Does altered biomechanics cause marrow edema?

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Abstract

PURPOSE: To determine if altered weight bearing causes the appearance of marrow edema on magnetic resonance (MR) images.

MATERIALS AND METHODS: Twelve volunteers underwent MR imaging with a short inversion time inversion-recovery (STIR) sequence at 1.5 T. The hips, knees, ankles, and feet were evaluated before and 2 weeks after altered weight bearing achieved with overpronation of one foot. Three volunteers underwent imaging a third time, 2 weeks after overpronation was stopped. Two observers assessed the images for evidence of marrow edema.

RESULTS: Changes were seen on images in 11 volunteers; the overpronated side only was affected in 10. Most changes occurred in the foot followed by the tibia and the femur. Most changes were a diffuse increase in marrow edema. In two volunteers, the changes resembled those of stress fractures.

CONCLUSION: Altered weight bearing should be added to the list of causes of increased medullary signal intensity (ie, marrow edema) on MR images.

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Skeletal Radiol. 2004 Jul;33(7):399-404. Epub 2004 May 11.

End plate marrow changes in the asymptomatic lumbosacral spine: frequency, distribution and correlation with age and degenerative changes.

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Abstract

PURPOSE: To investigate the frequency and distribution of end plate marrow signal intensity changes in an asymptomatic population and to correlate these findings with patient age and degenerative findings in the spine.

MATERIALS AND METHODS: MR imaging studies of the lumbosacral (LS) spine in 59 asymptomatic subjects were retrospectively reviewed by 2 musculoskeletal radiologists to determine the presence and location of fat-like and edema-like marrow signal changes about the end plates of the L1-2 through L5-S1 levels. The presence of degenerative changes in the spine was recorded as was patient age. Descriptive statistics were utilized to determine the frequency and associations of end plate findings and degenerative changes in the spine. Interobserver variability was determined by a kappa score. Binomial probability was used to predict the prevalence of the end plate changes in a similar subject population. The Fisher exact test was performed to determine statistical significance of the relationship of end plate changes with degenerative changes in the spine, superior versus inferior location about the disc and age of the patient population.

RESULTS: Focal fat-like signal intensity adjacent to the vertebral end-plate was noted in 15 out of 59 subjects by both readers, and involved 38 and 36 out of 590 end plates by readers 1 and 2, respectively. Focal edema-like signal intensity adjacent to the vertebral end plate was noted in 8 out of 59 subjects by both readers and involved 11 and 10 out of 590 end plates by readers 1 and 2, respectively. Either fat or edema signal intensity occurred most often at the anterior ($p<.05$) aspects of the mid-lumbar spine and was seen in an older sub-population of the study ($p<.05$).

CONCLUSION: End plate marrow signal intensity changes are present in the lumbar spine of some asymptomatic subjects with a characteristic location along the spine and in vertebral end plates.

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MeSH Terms

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J Orthop Res. 2010 Sep;28(9):1220-8.

Chronic axial compression of the mouse tail segment induces MRI bone marrow edema changes that correlate with increased marrow vasculature and cellularity.

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Abstract

Magnetic resonance imaging (MRI) of **bone** marrow **edema** (BME) has been found to be helpful in the diagnosis of back pain attributed to degenerative disk disease (DDD) and spondyloarthropathy (SA), but its interpretation is limited by a lack of knowledge of its nature and natural history. We assessed effects of compressive forces to mouse tail segments of WT and TNF-Tg mice with SA, via contrast enhanced-MRI and histology. Normalized marrow contrast enhancement (NMCE) of uninstrumented WT vertebrae significantly decrease, threefold ($p < 0.01$) from 8 to 12 weeks of age, while the NMCE of TNF-Tg vertebrae remained elevated. Compressive loading (6x body weight) increased NMCE twofold ($p < 0.02$) within 2 weeks in WT tails, which was equal to 6x loaded TNF-Tg tails within 4 weeks. Histology confirmed degenerative changes and that load-induced NMCE corresponded to increased **vascular** sinus tissue (35 +/- 3% vs. 19 +/- 3%; $p < 0.01$) and cellularity (4,235 +/- 886 vs.1,468 +/- 320 cells/mm(2); $p < 0.01$) for the loaded versus unloaded WT, respectively. However, micro-computed tomography (CT) analyses failed to detect significant load-induced changes to **bone**. While the **bone** marrow of loaded WT and TNF-Tg vertebrae were similar, histology demonstrated mild cellular infiltrate and increased osteoclastic resorption in the WT tails versus severe inflammatory-erosive arthritis in TNF-Tg joints. Significant ($p < 0.05$) decreases in cortical and trabecular **bone** volume in uninstrumented TNF-Tg versus WT vertebrae were confirmed by micro-CT. Thus, chronic load-induced DDD causes BME signals in vertebrae similar to those observed from SA, and both DDD and SA signals correlate with a conversion from yellow to red marrow, with increased vascularity.

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