



CIGNA MEDICAL COVERAGE POLICY

The following Coverage Policy applies to all health benefit plans administered by CIGNA Companies including plans formerly administered by Great-West Healthcare, which is now a part of CIGNA.

Subject Magnetic Resonance Imaging (MRI), Low-Field

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- Magnetic Resonance Imaging (MRI) of the Breast
- Magnetic Resonance Neurography
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Coverage Policy

CIGNA covers low-field strength magnetic resonance imaging (MRI) as medically necessary when used as guidance during interventional and intraoperative procedures.

CIGNA covers open-design magnetic resonance imaging (MRI) as medically necessary when conventional design is contraindicated.

CIGNA does not cover low-field strength magnetic resonance imaging (including positional MRI, upright MRI, and extremity-dedicated MRI) for ANY other indication because it is considered experimental, investigational or unproven.

General Background

Magnetic resonance (MR) imaging (MRI) is particularly useful in detecting soft tissue damage or disease. The quality of MR images depends not only upon field strength (above 1 Tesla is considered high), but also coil selection, contrast administration, imaging plane and sequence parameters, and ultimately interpreter

experience and familiarity with pathologic processes and surgical interventions. An intravenous contrast agent (gadolinium) is often used in conjunction with MRI. The strength of a magnetic field is measured in Tesla Units (T). Currently in MRI, the strength of a magnetic field may vary from 0.1–3.0 T for clinical MRI scanners. No professional society defines “low-field;” however, the scientific literature indicates the following: low-field strength is below 0.5 T; mid-field strength is 0.5 T, up to 0.9 T or 1 T; and high-field strength is at/and or above 1 T. Larger machines are needed for higher strength magnets, but low-field strength MRI can be delivered with: a conventional (closed) MRI scanner; a smaller magnet in an open (i.e., upright or seated) machine; or a smaller extremity-dedicated (i.e., in-office, portable, compact, e-MRI) MRI machine. Because of their size, these smaller machines are conducive to extremity imaging. High-field devices are usually closed-bore magnets due to the fact that the stronger magnetic fields (1–3 T) require more robust shielding and gradient structure to maintain field homogeneity. The open magnet’s field strength usually varies from 0.2–1.0 T.

U.S. Food and Drug Administration (FDA)

A number of magnetic resonance (MR) diagnostic devices (Class II) have received 510(k) premarket clearance and final approval by the FDA for use in the United States. There is no separate designation for low-field strength, open, positional or extremity-dedicated MRI.

Literature Review

Interventional and Intraoperative

Clinical MRI is mainly used as a diagnostic imaging modality, but MRI can be applied to guide various forms of intervention. Low-field strength MRI scanners allow real-time imaging during procedures whereas conventional MRI scanners with higher field strengths require the procedure be temporarily halted while a scan is performed. Interventional or intraoperative MRI (iMRI) is currently in use at academic and research facilities with specially equipped operating suites. All surgical instruments and devices used in an iMRI suite must be MRI-compatible if used within the magnet’s field. MRI as a guidance modality progressed from research sites to clinical practice in equipped facilities; therefore, there is limited evidence in the published peer-reviewed scientific literature providing direct head-to-head comparisons with conventionally-approached interventions. However, numerous small observational, non-comparative trials and textbooks indicate that low-field strength MR can be used to safely and effectively guide interventional and intraoperative procedures, including but not limited to neurosurgery, oncology, general surgery, otorhinolaryngology, and orthopedics procedures. The use of low-field strength MRI in guiding interventional and intraoperative procedures has become accepted as standard of care in those equipped facilities.

Open-design

Open (i.e., extremity, upright, positional) MRI allows for imaging without the patient being placed within an enclosed space. Open-design MRI has become the standard of care when conventional design is contraindicated. Specifically, this includes patients with pulmonary and/or cerebrovascular disease as well as patients who would require sedation for a conventional MRI such as severely claustrophobic or pediatric patients. Open MRI may be an option for obese patients who cannot safely fit in a conventional MRI machine (Calabrese, et al., 2009).

Other

Higher-field strength MRI provides better-quality images than low-field MRI; however, scientific literature does not agree if this translates into superior diagnostic power. A second issue raised in scientific literature is the interpretation of low-field strength MRI by non-radiologists in physician offices versus radiology specialists in a hospital setting. Current comparative studies are evaluating 1.5T against 3.0T or higher, but there are some small, older studies that compare low-field magnet strength to conventional (e.g., 1.5T) magnet strength; the majority of those are for musculoskeletal indications.

There is insufficient evidence in the peer-reviewed, scientific literature to support the use of low-field strength MRI — including positional MRI, upright MRI, and extremity-dedicated MRI — for any indication other than intraoperatively and when conventional design is contraindicated. Studies involving low-field strength MRI are small and primarily retrospective, and do not consistently demonstrate equivalent accuracy to conventional strength MRI or what, if any, clinical utility such as impact to health outcomes, is gained with its use.

Shoulder: Magee et al. (2003) used a 0.2 T open-design MR scanner for detection of supraspinatus tendon tears and labral tears in 40 patients, compared with 1.5 T and arthroscopy. MRI’s were prospectively interpreted by three musculoskeletal radiologists. Results showed that high-field strength images altered prospective

interpretations for nine patients (22.5%). Two anterior labral tears, a posterior labral tear, and two superior labral anteroposterior lesions could be definitively seen on the high-field strength unit but not on the low-field strength unit.

Loew et al. (2000) used a 0.2 T open-design MR scanner to prospectively compare low-field strength MR arthrography with 1.5 T MR arthrography of the shoulder. Thirty-eight patients either with suspected chronic instability (n=12) or rotator cuff abnormalities (n=26) were examined. Intra-articular injection of gadolinium was followed in randomized order, either first by imaging on an open 0.2 T system or on a 1.5 T system. The image material was evaluated independently by two radiologists in a blinded fashion with respect to overall image quality and the detection of rotator cuff as well as capsular and labral abnormalities. Surgical correlation was available in 27 (71%) of 38 patients. For both systems, sensitivity and specificity for rotator cuff tears were 100% each, and for labrum pathologies, these values were 100% and 93%, respectively. The authors stated they achieved a comparable diagnostic accuracy in diagnosing labral and joint capsule pathologies in the surgically proven cases. It should be noted that all images were evaluated by two radiologists, one was a musculoskeletal radiologist. Also, the total number of patients who were examined with both systems was limited, and the number of surgically proven cases was relatively low. Additionally, the image quality at 0.2 T was rated significantly lower than that of the high-field MR system due to limitations in signal-to-noise ratio. Longer acquisition times in order to compensate for these restrictions and to allow for sufficient in-plane resolution increases the risk of motion artifacts.

Tung et al. (2000) retrospectively used a 0.2 T open-design MR scanner to diagnose a glenoid superior labral anteroposterior tear compared to 1.5 T MR. Arthroscopy was the gold standard. Forty-one patients with tears and 26 symptomatic patients with normal superior labra were retrospectively evaluated. Both groups of patients had either high-field (n=46) or low-field strength (n=21) MRI and arthroscopy. For the diagnosis of labral tear, the accuracy of high-field MRI was 80%; the accuracy of low-field strength MRI was 67%. The statistical significance of these findings was not stated.

The following shoulder studies compared low-field strength MRI to surgical findings, not conventional MRI: Zlatkin et al. (2004) retrospectively assessed a 0.2 T extremity-dedicated MR scanner in 160 patients with suspected tears of the rotator cuff and glenoid labrum, compared with surgical findings. Surgical findings demonstrated rotator cuff tears in 131 patients and labral tears in 60 patients. For the rotator cuff, the sensitivity, specificity, positive predictive value, and negative predictive value were 90%, 93%, 98%, and 68% (two false-positives and 13 false-negatives), respectively. For the labrum, the sensitivity, specificity, positive predictive value, and negative predictive value were 55%, 100%, 100%, and 82% (24 false-negatives), respectively. All MRI's were interpreted by two radiologists with MR musculoskeletal fellowship training. The authors noted that shoulder MR imaging performed on extremity MR systems would be best performed and interpreted by MRI-trained, musculoskeletal radiologists, with experience in reading scans on the low-field strength MR systems, and working closely with the referring orthopedic surgeons. Shellock et al. (2001) used a 0.2 T extremity-dedicated MR scanner to detect lesions of the rotator cuff and glenoid labrum in 47 patients, and retrospectively compared to the surgical findings. For the rotator cuff tears, the sensitivity, specificity, positive predictive value, and negative predictive value were 89%, 100%, 100%, and 90% (three false-negatives), respectively. For the labral lesions, the sensitivity, specificity, positive predictive value, and negative predictive value were 89%, 95%, 80%, and 97% (two false-positives, one false-negative), respectively. The findings indicated that there was good agreement comparing the low-field strength MR results to the surgical findings for determination of lesions of the rotator cuff and glenoid labrum. It should be noted that MRI's were interpreted by three musculoskeletal radiologists.

Knee: Cardello et al. (2009) prospectively evaluated 95 patients experiencing pain and disability after meniscal repair. Patients underwent MRI and MR arthrography on both 0.2 T and 1.5 T magnets. Sensitivity, specificity, positive and negative predictive values and accuracy of MRI/MR arthrography were calculated. In 52 of 95 patients, second-look arthroscopy was the standard of reference; in the remaining 43 of 95 patients, clinical follow-up was used as the standard of reference. After intra-articular contrast medium administration, T2 weighted sequences resulted in an accuracy of 84% for low-field strength and 81% for high-field strength. T1 weighted sequences resulted in accuracy 82% for low-field strength and 88% for high-field strength. It is unknown if the difference in accuracy at optimal MR sequencing (84% low-field strength vs. 88% high-field strength) is statistically significant.

Oei et al. (2003) conducted a literature review and performed a meta-analysis including 29 articles to assess the diagnostic performance of MRI of the menisci and cruciate ligaments and to assess the effect of study design characteristics and magnetic field strength on diagnostic performance. Results indicated that higher magnetic field strength significantly ($p=.003$) improved discriminatory power for anterior cruciate ligament tears. When all lesions were combined in one overall summary receiver operating characteristic (ROC) analysis, magnetic field strength was a significant (relative diagnostic odds ratio, 1.97) but modest predictor of diagnostic performance.

Cotton et al. (2000) used a 0.2 T scanner to compare the diagnostic efficacy of low- and high-field strength MR imagers in the diagnosis of anterior cruciate ligament tears and meniscus tears in 219 patients with suspected internal derangement of the knee. Selection of patients for surgery was performed using only the data from the 1.5 T magnets. MRI scans were interpreted by musculoskeletal radiologists in a hospital setting. Therefore in 90 patients, using arthroscopy findings as the standard reference, the authors found no significant difference in diagnostic performance between low and high-field strength MR imaging of the knee. The low-field scan took 15 minutes longer than the 1.5T scan. In addition, the two reviewers were musculoskeletal radiologists.

Spine: There are limited spinal studies comparing low-field magnet strength to conventional magnet strength. Weishaupt et al. (2000) used a 0.5 T open-design MR scanner to evaluate whether positional MRI of the lumbar spine demonstrated nerve root compromise not visible on supine 1.0 T MR with a dedicated, receive-only spinal coil. A total of 30 patients with chronic low back pain unresponsive to nonsurgical treatment and with disk abnormalities but without compression of neural structures were included. Foraminal size was assessed qualitatively in supine, seated flexion, and seated extension positions. A p value less than .05 was considered to indicate statistical significance. The images were interpreted by two musculoskeletal radiologists. Although the authors stated that positional MRI more frequently demonstrated minor neural compromise than did supine MRI, it should be noted that differences in dimensions of the neural foramina from supine to seated (flexion and extension) were not statistically significant.

Rheumatology: The majority of cited studies in the peer-reviewed scientific literature evaluating the utility of MRI in diagnosing, disease/treatment monitoring and prognostication of rheumatoid arthritis (RA) are specific to conventional (1.5T) MRI strength (Narváez, et al., 2008; Quinn, et al., 2005; Jarrett, et al., 2006; Durez, et al., 2007; Benton, et al., 2004; McQueen, et al., 2005). It should be noted that characteristic x-ray findings are part of the American College of Rheumatology classification criteria for Rheumatoid Arthritis. Additionally, the currently utilized Outcome MEasures in Rheumatoid Arthritis Clinical Trials (OMERACT) MRI scoring system is based upon conventional strength (1.5T) MRI (Ostergaard, et al., 1996; McQueen, et al., 1998; McGonagle, et al., 1999).

Evidence in the published, peer-reviewed scientific literature does not clearly and consistently demonstrate that low-field MRI diagnostic capability is equivalent to the scope of conventional MRI diagnostic capability. There are some small head-to-head comparisons of conventional strength MRI and low-field strength MRI in patients with rheumatoid arthritis. The small number of patients in these studies limits the power of the statistical results and the specialty of the MRI interpreter(s) was not specified. Freeston et al. (2007) compared x-ray and 0.2 T extremity-dedicated MRI with the reference standard 1.5 T MRI in 15 patients with active RA (median disease duration 11 years) on leflunomide. With high field MRI considered the reference, the sensitivity, specificity and accuracy of eMRI for erosions were 46%, 94% and 55%, and the corresponding values for x-ray were 6%, 100% and 23%, respectively. Schirmer et al. (2007) compared 0.2 T MRI with 1.5 T MRI in 17 RA patients. Neither of the imaging techniques evaluated in this study was regarded as the gold standard. Therefore, the κ coefficient was used to describe agreement between the two techniques. Overall agreement between both MR techniques was good to excellent. There was moderate to good agreement of the tenosynovitis scores ($\kappa =0.51-0.65$). Finger joints, bases of metacarpal bones, carpal bones, radius and ulna were scored for the presence of erosions. There was good to excellent agreement for the finger joints ($\kappa =0.65-0.95$). Agreement in the detection of erosions was slightly poorer for the proximal interphalangeal joints. κ values for the wrist joints showed wide variation from good agreement (lowest κ of 0.65) to full agreement of both MR systems ($\kappa =1.0$). Using conventional MRI as the standard reference, Ejbjerg et al. (2005) evaluated findings from a 0.2 T extremity-dedicated MR scanner in 37 patients with RA. Low-field strength MR wrist and metacarpophalangeal (MCP) joint imaging demonstrated sensitivity, specificity, and accuracy for erosions of 94%, 93%, 94%; for synovitis, 90%, 96%, and 94%; and for bone marrow edema, 39%, 99%, and 95%. Taouli et al. (2004) used a 0.2 T extremity-dedicated MR scanner to detect and grade bone erosions, joint-space narrowing, and synovitis in the hands and wrists of 18 patients with rheumatoid arthritis. For the detection of bone erosion, there was no statistical difference ($p=0.71$) between 1.5T MRI and 0.2T MRI. For the evaluation of synovitis, 1.5T MRI and

0.2T MRI were equivalent ($p=.14$). Different T2-weighted sequences for conventional and low-field strength MRI were used. Lindegaard et al. (2006) assessed the predictive value of low-field 0.2T strength MRI in 24 early RA patients; however, there was no comparison to conventional MRI. Duer-Jensen et al. (2008) compared two different 0.2T extremity-dedicated MRI machines and x-ray, using CT as the reference standard. A total of 20 RA patients and five controls were studied. Accuracy results for the two 0.2T strength MRI machines were 90% and 88%, and x-ray was 93%. Performance characteristics of different machines can vary. There was no comparison to conventional MRI strength drawn or conclusions drawn re any statistical significance of the findings.

Miscellaneous: MRI studies reported in the literature are generally based on intermediate- or high-field MRI. There is insufficient evidence in the peer-reviewed, scientific literature to support the use of low-field strength MRI for any indication other than intraoperatively and when conventional design is contraindicated, including but not limited to the following: breast (Paakko, et al., 2005); cardiac (Klein, et al., 2007; Rupprecht, et al., 2002); cerebral/stroke (Terada, et al., 2006; Mehdizade, et al., 2003); pulmonary (Abolmaali, et al., 2004; Wagner, et al., 2001); renal (Stecco, et al., 2007; Kajander, et al., 2000); multiple sclerosis (Ertl-Wagner, et al., 2001) and retrocochlear disorders (Dubrulle, et al., 2002).

Professional Societies/Organizations

American College of Radiology (ACR) MRI Practice Guidelines: The ACR Shoulder MRI Practice Guideline states that various investigators using different equipment and scanning parameters have reached contradictory conclusions regarding the diagnostic performance of low-field-strength MR scanners for shoulder disorders (2006). In other MRI Practice Guidelines such as Ankle and Hindfoot (2006) and Elbow (2006), the ACR notes that if MRI is performed on an extremity-dedicated scanner, the reduced signal-to-noise ratio (SNR) inherent at lower field strength may necessitate modifications in the imaging parameters. Additionally, low-field dedicated extremity machines are more susceptible to artifacts and degraded image quality than their high-field counterparts. The ACR Wrist (2007) MRI Practice Guidelines notes that for some indications, imaging on a low-field system may be disadvantageous compared to a high-field system.

The ACR Knee (2010) MRI Practice Guideline states that diagnostic quality knee MRI is possible using a variety of magnet designs (closed bore whole body, open whole body, dedicated extremity) and field strengths. Regardless of magnet design, a local coil is mandatory to maximize signal-to-noise ratio. Typically, a cylindrical coil (often called an "extremity" or "knee" coil) surrounds the knee. Certain MR systems (e.g., those using low-field-strength magnets) have inherently lower signal-to-noise ratios than others. For some indications like high-resolution imaging of articular cartilage, images obtained with a low-field system will be lower quality compared to those acquired on a high-field system. Detection of other conditions, such as meniscal and anterior cruciate ligament tears, is less dependent on magnet strength and design.

The ACR Spine MRI Practice Guideline states that MRI is regarded as the diagnostic modality of choice for evaluation of possible disc herniation with a high sensitivity for demonstrating the presence of nerve root compression (2006). Regarding degenerative disc disease, ACR states MRI has proven to be the technique of choice for imaging of intervertebral disc degeneration. It should be noted that this guideline does not address field strength, weight-bearing, standing, upright, axial-loading or vertical positioning (2006).

The ACR Non-breast MRI-guided Procedures Practice Guideline notes that low-field MRI provides sufficient image quality for interactive procedure guidance (2008).

American College of Occupational and Environmental Medicine (ACOEM): ACOEM revised their Low Back Disorders guideline in 2007, and stated "Standing or weight-bearing MRI for any back or radicular pain syndrome or condition is Not Recommended (Insufficient)."

American College of Rheumatology: A 2006 report of the American College of Rheumatology on extremity MRI in rheumatology notes that most of the literature "assessing the utility of peripheral joint MRI has used high-field, not low-field extremity MRI; therefore, actual sensitivity, specificity, and predictive value of the low-field scanners available for the practicing rheumatologists are not known. The benefits of low-field strength extremity MRI for the diagnosis and management of rheumatoid arthritis are still being elucidated." In the American College of Rheumatology guidelines for the management of rheumatoid arthritis (2002), radiography of selected involved joints is addressed, but no other type of imaging is discussed.

Washington State Health Care Authority: Washington State published a Health Technology Assessment Upright MRI: Effectiveness of upright MRI for evaluation of patients with suspected spinal or extra-spinal joint dysfunction (2007). There is a paucity of literature to validate upright MRI use as diagnostic tool or its reliability for diagnosing such conditions. No studies validating the diagnostic accuracy of upright MRI were found.

Washington State Department of Labor and Industries: Washington State published a Health Technology Assessment on Standing, Weight-Bearing, Positional, or Upright MRI (2006). Some conclusions included:

- There is limited scientific data available on the accuracy and diagnostic utility of standing, upright, weight-bearing or positional MRI.
- There is no evidence from well-designed clinical trials demonstrating the accuracy or effectiveness of weight-bearing MRI for specific conditions or patient populations.
- Due to the lack of evidence addressing diagnostic accuracy or diagnostic utility, standing, weight-bearing, positional MRI is considered investigational and experimental.

Summary

MRI can be used to safely and effectively guide interventional and intraoperative procedures, and has become standard of care in equipped facilities. Open-design MRI may be clinically beneficial in certain patients when conventional design is contraindicated.

There is insufficient evidence in the published peer-reviewed literature to support the use of low-field strength MRI for any indication other than intervention guidance. There is a lack of data: clarifying the impact of treatment decisions—based upon low-field interpretation—on patient outcomes; addressing accuracy and impact of interpretation of low-field MR images outside the hospital setting (i.e., non-radiologist interpretation); addressing any value of dynamic or positional low-field MRI compared to conventional MRI, or impact to patient outcomes; and clarifying what role low-field imaging should hold in the diagnostic algorithm of joint conditions. Due to insufficient evidence, it remains unknown if substituting low-field strength MRI in place of conventional MRI causes a negative impact to diagnostic accuracy, treatment planning and overall patient outcomes. The limited evidence fails to prove that the use of low-field strength MRI in place of conventional MRI improves diagnostic accuracy, treatment planning and overall patient outcomes.

Coding/Billing Information

Note: This list of codes may not be all-inclusive.

Covered when medically necessary when used as guidance during interventional and intraoperative procedures or when conventional design is contraindicated:

CPT* Codes	Description
76498	Unlisted magnetic resonance procedure (eg, diagnostic, interventional)
76499	Unlisted diagnostic radiological procedure

HCPCS Codes	Description
S8042	Magnetic resonance imaging (MRI), low-field

ICD-9-CM Diagnosis Codes	Description
	All codes

*Current Procedural Terminology (CPT®) © 2010 American Medical Association: Chicago, IL.

References

1. Abolmaali ND, Schmitt J, Krauss S, Bretz F, Deimling M, Jacobi V, et al. MRI of lung parenchyma at 0.2 T: evaluation of imaging techniques, comparative study with chest radiography and interobserver analysis. *Eur Radiol*. 2004 Apr;14(4):703-8. Epub 2004 Feb 10.
2. American College of Occupational and Environmental Medicine (ACOEM). Guideline: Low back disorders. Revised 2007. Accessed April 2011. Available at URL address: http://www.ngc.gov/summary/summary.aspx?doc_id=12540&nbr=006456&string=orthopedic
3. American College of Radiology. Practice Guidelines. Accessed April 2011. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/dx.aspx
4. American College of Rheumatology. Extremity Magnetic Resonance Imaging Task Force. Extremity magnetic resonance imaging in rheumatoid arthritis: report of the American College of Rheumatology Extremity Magnetic Resonance Imaging Task Force. *Arthritis Rheum*. 2006 Apr;54(4):1034-47.
5. American College of Rheumatology Subcommittee on Rheumatoid Arthritis Guidelines. Guidelines for the management of rheumatoid arthritis: 2002 update. *Arthritis Rheum* 2002;46 :328–3. Accessed April 2011. Available at URL address: <http://www.rheumatology.org/practice/clinical/guidelines/raguidelines02.pdf>
6. Benton N, Stewart N, Crabbe J, Robinson E, Yeoman S, McQueen FM. MRI of the wrist in early rheumatoid arthritis can be used to predict functional outcome at 6 years. *Ann Rheum Dis*. 2004 May;63(5):555-61.
7. Blanco RT, Ojala R, Kariniemi J, Perälä J, Niinimäki J, Tervonen O. Interventional and intraoperative MRI at low field scanner--a review. *Eur J Radiol*. 2005 Nov;56(2):130-42. Review.
8. Calabrese M, Brizzi D, Carbonaro L, Chiaramondia M, Kirchin MA, Sardanelli F. Contrast-enhanced breast MR imaging of claustrophobic or oversized patients using an open low-field magnet. *Radiol Med*. 2009 Feb 4. [Epub ahead of print]
9. Cardello P, Gigli C, Ricci A, Chiatti L, Voglino N, Pofi E. Retears of postoperative knee meniscus: findings on magnetic resonance imaging (MRI) and magnetic resonance arthrography (MRA) by using low and high field magnets. *Skeletal Radiol*. 2009 Feb;38(2):149-56. Epub 2008 Oct 10.
10. Centers for Medicare & Medicaid Services (CMS). Medicare coverage database National Coverage Determination (NCD). NCD for magnetic resonance imaging (MRI) (220.2). Effective 2/24/2011. Accessed April 2011. Available at: <http://www.cms.gov/medicare-coverage-database/details/ncd-details.aspx?NCDId=177&ncdver=4&CoverageSelection=National&Keyword=Magnetic+Resonance+Imaging+&KeywordLookup=Title&KeywordSearchType=And&bc=gAAAAACAAAAA&>
11. Cotten A, Delfaut E, Demondion X, Lapegue F, Boukhelifa M, Boutry N, et al. MR imaging of the knee at 0.2 and 1.5 T: correlation with surgery. *AJR Am J Roentgenol*. 2000 Apr;174(4):1093-7.
12. Dubrulle F, Delomez J, Kiaei A, Berger P, Vincent C, Vaneecloo FM, et al. Mass screening for retrocochlear disorders: low-field-strength (0.2-T) versus high-field-strength (1.5-T) MRI. *AJNR Am J Neuroradiol*. 2002 Jun-Jul;23(6):918-23.
13. Duer-Jensen A, Ejbjerg B, Albrecht-Beste E, Vestergaard A, Møller Døhn U, Lund Hetland M, et al. Does low-field dedicated extremity MRI (E-MRI) reliably detect RA bone erosions? A comparison of two different E-MRI units and conventional radiography with high resolution CT. *Ann Rheum Dis*. 2008 Aug 21. [Epub ahead of print]
14. Durez P, Malghem J, Nzeusseu Toukap A, Depresseux G, Lauwerys BR, et al. Treatment of early rheumatoid arthritis: a randomized magnetic resonance imaging study comparing the effects of methotrexate alone, methotrexate in combination with infliximab, and methotrexate in combination with intravenous pulse methylprednisolone. *Arthritis Rheum*. 2007 Dec;56(12):3919-27.

15. Ejbjerg BJ, Narvestad E, Jacobsen S, Thomsen HS, Ostergaard M. Optimised, low cost, low-field dedicated extremity MRI is highly specific and sensitive for synovitis and bone erosions in rheumatoid arthritis wrist and finger joints: comparison with conventional high-field MRI and radiography. *Ann Rheum Dis*. 2005 Sep;64(9):1280-7. Epub 2005 Jan 13
16. Ertl-Wagner BB, Reith W, Sartor K. Low field-low cost: can low-field magnetic resonance systems replace high-field magnetic resonance systems in the diagnostic assessment of multiple sclerosis patients? *Eur Radiol*. 2001;11(8):1490-4.
17. Freeston JE, Conaghan PG, Dass S, Vital E, Hensor EM, Stewart SP, et al. Does extremity-MRI improve erosion detection in severely damaged joints? A study of long-standing rheumatoid arthritis using three imaging modalities. *Ann Rheum Dis*. 2007 Nov;66(11):1538-40. Epub 2007 Jul 31.
18. Ghazinoor S, Crues JV 3rd, Crowley C. Low-field musculoskeletal MRI. *J Magn Reson Imaging*. 2007 Feb;25(2):234-44.
19. Jarrett SJ, Conaghan PG, Sloan VS, Papanastasiou P, Ortmann CE, O'Connor PJ, et al. Preliminary evidence for a structural benefit of the new bisphosphonate zoledronic acid in early rheumatoid arthritis. *Arthritis Rheum*. 2006 May;54(5):1410-4.
20. Kajander S, Kallio T, Alanen A, Komu M, Forsstrom J. Imaging end-stage kidney disease in adults. Low-field MRI with magnetization transfer vs. ultrasonography. *Acta Radiol*. 2000 Jul;41(4):357-60.
21. Klein HM, Meyners W, Neeb B, Labenz J, Truümmeler KH. Cardiac magnetic resonance imaging using an open 0.35 T system. *J Comput Assist Tomogr*. 2007 May-Jun;31(3):430-4.
22. Lindegaard HM, Vallo J, Horslev-Petersen K, Junker P, Ostergaard M. Low-cost, low-field dedicated extremity magnetic resonance imaging in early rheumatoid arthritis: a 1-year follow-up study. *Ann Rheum Dis*. 2006 Sep;65(9):1208-12.
23. Loew R, Kreitner KF, Runkel M, Zoellner J, Thelen M. MR arthrography of the shoulder: comparison of low-field (0.2 T) vs high-field (1.5 T) imaging. *Eur Radiol*. 2000;10(6):989-96.
24. Magee T, Shapiro M, Williams D. Comparison of high-field-strength versus low-field-strength MRI of the shoulder. *AJR Am J Roentgenol*. 2003 Nov;181(5):1211-5.
25. McGonagle D, Conaghan PG, O'Connor P, Gibbon W, Green M, Wakefield R, et al. The relationship between synovitis and bone changes in early untreated rheumatoid arthritis: a controlled magnetic resonance imaging study. *Arthritis Rheum*. 1999 Aug;42(8):1706-11.
26. McQueen F, Beckley V, Crabbe J, Robinson E, Yeoman S, Stewart N. Magnetic resonance imaging evidence of tendinopathy in early rheumatoid arthritis predicts tendon rupture at six years. *Arthritis Rheum*. 2005 Mar;52(3):744-51.
27. McQueen FM, Stewart N, Crabbe J, Robinson E, Yeoman S, Tan PL, McLean L. Magnetic resonance imaging of the wrist in early rheumatoid arthritis reveals a high prevalence of erosions at four months after symptom onset. *Ann Rheum Dis*. 1998 Jun;57(6):350-6.
28. Mehdizade A, Somon T, Wetzel S, Kelekis A, Martin JB, Scheidegger JR, et al. Diffusion weighted MR imaging on a low-field open magnet. Comparison with findings at 1.5T in 18 patients with cerebral ischemia. *J Neuroradiol*. 2003 Jan;30(1):25-30.
29. Narváez J, Sirvent E, Narváez JA, Bas J, Gómez-Vaquero C, Reina D, et al. Usefulness of magnetic resonance imaging of the hand versus anticyclic citrullinated peptide antibody testing to confirm the diagnosis of clinically suspected early rheumatoid arthritis in the absence of rheumatoid factor and radiographic erosions. *Semin Arthritis Rheum*. 2008 Oct;38(2):101-9. Epub 2008 Jan 25.

30. Oei EH, Nikken JJ, Verstijnen AC, Ginai AZ, Myriam Hunink MG. MRI of the menisci and cruciate ligaments: a systematic review. *Radiology*. 2003 Mar;226(3):837-48. Epub 2003 Jan 15.
31. OMERACT. Accessed April 2011. Available at URL address: <http://www.omeract.org/>
32. Ostergaard M, Hansen M, Stoltenberg M, Lorenzen I. Quantitative assessment of the synovial membrane in the rheumatoid wrist: an easily obtained MRI score reflects the synovial volume. *Br J Rheumatol*. 1996 Oct;35(10):965-71.
33. Paakko E, Reinikainen H, Lindholm EL, Rissanen T. Low-field versus high-field MRI in diagnosing breast disorders. *Eur Radiol*. 2005 Jul;15(7):1361-8. Epub 2005 Feb 12.
34. Quinn MA, Conaghan PG, O'Connor PJ, Karim Z, Greenstein A, Brown A, et al. Very early treatment with infliximab in addition to methotrexate in early, poor-prognosis rheumatoid arthritis reduces magnetic resonance imaging evidence of synovitis and damage, with sustained benefit after infliximab withdrawal: results from a twelve-month randomized, double-blind, placebo-controlled trial. *Arthritis Rheum*. 2005 Jan;52(1):27-35.
35. Rupprecht T, Nitz W, Wagner M, Kreissler P, Rascher W, et al. Determination of the pressure gradient in children with coarctation of the aorta by low-field magnetic resonance imaging. *Pediatr Cardiol*. 2002 Mar-Apr;23(2):127-31. Epub 2002 Feb 19.
36. Schirmer C, Scheel AK, Althoff CE, Schink T, Eshed I, Lembcke A, et al. Diagnostic quality and scoring of synovitis, tenosynovitis and erosions in low-field MRI of patients with rheumatoid arthritis: a comparison with conventional MRI. *Ann Rheum Dis*. 2007 Apr;66(4):522-9. Epub 2006 Oct 26.
37. Shellock FG, Bert JM, Fritts HM, Gundry CR, Easton R, Crues JV 3rd. Evaluation of the rotator cuff and glenoid labrum using a 0.2-Tesla extremity magnetic resonance (MR) system: MR results compared to surgical findings. *J Magn Reson Imaging*. 2001 Dec;14(6):763-70.
38. Stecco A, Ortonzo P, Armienti F, Borraccino C, Fossaceca R, Canalis L, et al. Contrast-bolus MR angiography of the transplanted kidney with a low-field (0.5-T) scanner: diagnostic accuracy, sensitivity and specificity of images and reconstructions in the evaluation of vascular complications. *Radiol Med (Torino)*. 2007 Oct;112(7):1026-35. Epub 2007 Oct 21.
39. Taouli B, Zaim S, Peterfy CG, Lynch JA, Stork A, Guermazi A, Fan B, Fye KH, Genant HK. Rheumatoid arthritis of the hand and wrist: comparison of three imaging techniques. *AJR Am J Roentgenol*. 2004 Apr;182(4):937-43.
40. Terada H, Gomi T, Harada H, Chiba T, Nakamura T, Iwabuchi S, et al. Development of diffusion-weighted image using a 0.3T open MRI. *J Neuroradiol*. 2006 Feb;33(1):57-61.
41. Tung GA, Entzian D, Green A, Brody JM. High-field and low-field MRI of superior glenoid labral tears and associated tendon injuries. *AJR Am J Roentgenol*. 2000 Apr;174(4):1107-14.
42. Wagner M, Bowing B, Kuth R, Deimling M, Rascher W, Rupprecht T. Low field thoracic MRI--a fast and radiation free routine imaging modality in children. *Magn Reson Imaging*. 2001 Sep;19(7):975-83
43. Washington State Health Care Authority. Health Technology Assessment. Upright MRI: Effectiveness of upright MRI for evaluation of patients with suspected spinal or extra-spinal joint dysfunction. May 11, 2007. Accessed April 2011. Available at URL address: http://www.hta.hca.wa.gov/documents/uMRI_final_report.pdf
44. Washington State Department of Labor and Industries. Health Technology Assessment Standing, Weight-Bearing, Positional, or Upright Magnetic Resonance Imaging. May 31, 2006. Accessed April 2011. Available at URL address: <http://www.lni.wa.gov/ClaimsIns/Files/OMD/StandMriTAMay2006.pdf>

45. Weishaupt D, Schmid MR, Zanetti M, Boos N, Romanowski B, Kissling RO, et al. Positional MRI of the lumbar spine: does it demonstrate nerve root compromise not visible at conventional MRI? Radiology. 2000 Apr;215(1):247-53.
46. Yrjänä SK, Tuominen J, Koivukangas J. Intraoperative magnetic resonance imaging in neurosurgery. Acta Radiol. 2007 Jun;48(5):540-9.
47. Zlatkin MB, Hoffman C, Shellock FG. Assessment of the rotator cuff and glenoid labrum using an extremity MR system: MR results compared to surgical findings from a multi-center study. J Magn Reson Imaging. 2004 May;19(5):623-31.

Policy History

Pre-Merger Organizations	Last Review Date	Policy Number	Title
CIGNA HealthCare	6/15/2008	0444	Magnetic Resonance Imaging (MRI) Low-Field

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