Positional Magnetic Resonance Imaging

Description

Positional magnetic resonance imaging (MRI) allows imaging of the patient in various positions, including sitting and standing. This technology is being evaluated for the diagnosis of patients with position-dependent back pain.

Background

Determining the cause of back pain is a complex task. In some patients, extensive evaluation with various imaging modalities does not lead to a definitive diagnosis. Some recent studies have suggested that imaging the body in various positions with “loading” of the spine may lead to more accurate diagnosis. This loading can be accomplished by having the patient sit or stand upright. Also, imaging can be completed with the patient in the position that causes the symptom(s). This is being evaluated in suspected nerve root compression and in some cases of spondylolisthesis.

An open MRI system has been developed that allows imaging of the patient in various positions. The imaging can be conducted with partial or full weight bearing. Dynamic-kinetic imaging (images obtained during movement) can also be obtained with this system. Conventional MRI of the spine is typically completed with the patient in a recumbent position. Weight bearing can be simulated by imaging in the supine position with a special axial loading device.

One concern with positional MRI is the field strength of the scanners. Today’s clinical MRI scanners may operate at a field strength between 0.1 Tesla (T) to 3 T and are classified as either low-field (<0.5 T), mid-field (0.5-1.0 T), or high-field (>1.0 T). Low-field MRI is typically used in open scanners. Open scanners are designed for use during interventional or intraoperative procedures, when a conventional design is contraindicated (eg, an obese or claustrophobic patient), or for changes in patient positioning.

In general, higher field strength results in an increase in signal-to-noise ratio, spatial resolution, contrast and speed. Thus, low-field scanners produce poorer-quality images compared to high-field scanners, and the longer acquisition times with low-field scanners increases the possibility of image degradation due to patient movement. However, field strength has less of an effect on the contrast-to-noise ratio, which determines the extent to which adjacent structures can be distinguished from one another.
Positional (nonrecumbent) magnetic resonance imaging (MRI) is considered investigational, including its use in the evaluation of patients with cervical, thoracic, or lumbosacral back pain.

Rationale

In evaluating this approach to imaging, it is important to first determine if positional magnetic resonance imaging (MRI) results in additional findings. However, it is also important to determine if treatment of these additional findings results in improved outcomes. This additional step is important given the previously described false-positive findings with MRI of the spine. For example, Jarvik et al (2001) reported that many routine MRI findings have a high prevalence in subjects without low back pain and that findings such as bulging discs and disc protrusion are of limited diagnostic use. They also reported that the less common findings of moderate or severe central stenosis, root compression, and disc extrusion were more likely to be clinically relevant. (1)

In 2011, the Tufts Medical Center Evidence-based Practice Center for the Agency for Healthcare Research and Quality (AHRQ) prepared a systematic review of emerging MRI technologies for musculoskeletal imaging under loading stress. (2) Included were 36 studies that used positional weight-bearing MRI in patients with musculoskeletal conditions. Also included were studies evaluating axial compression devices. Most studies were cross-sectional or had case-control designs. The most commonly imaged body region was the lumbar spine. Four studies of lumbar spine were identified that compared positional weight-bearing MRI with conventional MRI, myelography, or non-weight-bearing imaging in the same MRI device, however, these studies did not report the effect of the technology on patient outcomes. Two studies of foot imaging that compared weight-bearing MRI with MRI in the supine position with the same MRI device found that the 2 techniques provided similar information. Two studies of knee joint imaging found differences between weight-bearing MRI and non-weight-bearing MRI using the same device; no functional outcomes were reported. The potential effect on image quality of low magnetic field strengths (≤ 0.6 T) in weight-bearing MRI scanners was not assessed. The systematic review concluded that despite the large number of available studies, considerable uncertainty remains about the utility of this technique for the clinical management of musculoskeletal conditions. Examples of primary studies and key studies published after the systematic review are described next.
Comparison of Positional MRI in Neutral, Flexion, and Extension (Kinetic MRI)

One of the studies included in the systematic review was a 2008, quantitative comparison of positional MRI in neutral, flexion, and extension positions by Zou et al. (3) The study included 553 patients (mean age, 46 years; range: 18–76) with symptomatic back pain with/without radiculopathy who were referred for kinetic/positional MRI (0.6 T). Disc bulge on MRI in the 3 positions (neutral, flexion, and extension) was quantified by MRI analysis software, and the bulge size was compared independently by 2 spine surgeons who were unaware of the patient’s history and clinical findings. Increased disc bulge at extension and flexion, in comparison with neutral, was seen in 16% and 12% of discs, respectively. Diagnosis of grade 2 disc bulge that had been categorized as grade 1 in neutral position (ie, missed diagnosis) was 19.5% for extension and 15.3% for flexion MRI. Vitaz et al (2004) reported changes in spinal cord compression, angulation, and alignment that occurred during physiologic movement in 20 patients with cervical spine disorders. (4) They reported excellent or good image quality in 90% of cases.

Systematic reviews published in 2014 indicate that the literature on kinetic MRI consists primarily of examining anatomic changes in neutral, flexion, extension, and axial rotation. (5, 6) For example, kinetic MRI studies in healthy and symptomatic individuals have identified changes in neuroforaminal size, cord compression, cord length, cross-sectional area, ligamentum flavum thickness, and motion at the index and adjacent levels. Evidence for the clinical utility of kinetic MRI is needed.

Comparison Between Seated and Supine MRI

Another study included in the AHRQ systematic review was by Weishaupt et al (2000), who reported finding 13 instances of nerve root deviation in the seated extension position in a 0.5 T positional MRI compared with 10 instances in the supine position in a 1.0 T conventional MRI in a group of 30 patients with chronic low back pain. (7) Diagnoses in the supine position changed in 4 disks (5%) in seated flexion and in 7 disks (9%) in seated extension. They also reported that positional pain score differences were related to foraminal size.

Ferreiro Perez et al (2007) compared recumbent and upright-sitting positions in 89 patients with disc herniation or spondylolisthesis (cervical or lumbar spine). (8) Using a 0.6 T Upright MRI system for both positions, pathology (disc herniation or spondylolisthesis) was identified in 68 patients (76%). Images from 18 patients (20%) were not interpretable due to motion artifact. Pathologic features were better identified (ie, either only evident or seen to be enlarged) in 52 (76%) of the 68 patients (76%) when in the sitting position; 10 of these were only observed in the sitting position. Pathologic features were better identified in the recumbent position in 11 (16%) of the 68 patients (16%). The overall underestimation rate was calculated to be 62% for patients in the recumbent position and 16% for those in the upright-seated position. This research suggests that there may be advantages when the position during imaging is matched with the positional symptoms of the patient. However, a more appropriate comparison group would be a standard recumbent clinical MRI system (eg, field strength >0.6 T). In addition, technical problems with motion artifact were due to poor stabilization in an upright-sitting position.
Comparison Between Standing and Supine MRI

In a 2013 study by Tarantino, 57 patients with low back pain when standing (50% also had back pain in the supine position) received an MRI in both upright and recumbent positions using a 0.25 T tilting system. (7) A table tilt of 82 degrees was used to reproduce the orthostatic position without the patient instability associated with standing at 90 degrees. In comparison with the supine position, there was a significant decrease in intervertebral disc thickness (11.2 mm vs. 12.9 mm) along changes in other measures and a qualitative increase in the volume of disc protrusions and/or spondylolisthesis in the upright position.

Comparison Between Standing and Axial Loaded Supine MRI

A 2008 study compared vertical (standing) MRI and recumbent MRI with axial loading in patients with lumbar spinal stenosis. (10) Sixteen patients with neurogenic claudication experienced mainly during walking or in an erect position, were recruited for this phase of the study. Each patient underwent 4 scans with a 0.6 T Upright MRI system, consisting of vertical, horizontal with compression at a load of 40% of body weight, horizontal with no load, and finally horizontal with a 50% axial load. All horizontal scans were conducted with a cushion placed below the lower back to induce extension of the lumbar spine. Results showed similar dural sac cross-sectional area between the two positions, suggesting that the standing position may be adequately simulated while recumbent by axial loading and lordosis. Results were not correlated with patient symptoms in this study.

Comparison Between Upright Positional MRI and Standing Radiographs

In 2013, Diefenbach et al assessed whether upright positional MRI could be a radiation-free method of monitoring spinal curvature in adolescent idiopathic scoliosis. (11) Twenty-five patients received anterior-posterior and lateral plain radiographs and an upright MRI, which was performed at the manufacturer’s facility. Three MRI scans were repeated due to patient movement. Assessment by 2 independent observers resulted in high correlations between radiograph and MRI for Cobb angle for (r=0.901) and for kyphosis (r=0.943). Inter-rater reliability was high for both radiographs and upright MRI.

Ongoing and Unpublished Clinical Trials

A search of ClinicalTrials.gov on March 26, 2015 did not identify any ongoing or unpublished trials that would likely influence this policy.

Practice Guidelines and Position Statements

No guidelines or statements were identified.

U.S. Preventive Services Task Force

Not applicable
Summary

No studies were found that described clinical outcomes of patients whose treatments were selected on new findings of positional MRI, and the incremental benefit of this imaging in clinical practice is not yet known. The clinical benefit of basing treatment decisions, including surgery, on these additional findings needs to be established. Studies that correlate the positional MRI findings with patient symptoms and outcomes of treatment are also needed. Another concern that needs further study is that positional scans, which use lower strength magnets, may be of lesser quality than those from traditional supine MRI. The scientific evidence at this time does not permit conclusions concerning the effect of this technology on health outcomes. Therefore, the use of positional MRI is considered investigational.

Medicare National Coverage

There is no national coverage determination (NCD).

References


**Policy History**

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<th>Date</th>
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<tr>
<td>June 2013</td>
<td>Update Policy</td>
<td>Policy updated with literature review. References 7 and 9 added; policy statement unchanged.</td>
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**Keywords**

Kinetic MRI
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Magnetic Resonance Imaging, Positional
Positional MRI
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This policy was approved by the FEP® Pharmacy and Medical Policy Committee on June 19, 2015 and is effective July 15, 2015.

*Signature on file*

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