MR in Low Back Pain: What Should We Do & Why?

Johan Van Goethem, University of Antwerp, Belgium

Reasons for Imaging in Low Back Pain

Imaging in low back pain (LBP) is mainly done to (1) rule out serious pathology and/or (2) to detect and localize/target treatable causes. The group of treatable causes is mainly comprised of disc herniations and degenerative disc disease, although only a minority of these patients is "treated" specifically targeted toward these causes of low back pain. Other reasons for imaging may include (3) reassurance of the patient and/or clinician and (4) monitoring of therapy and/or follow-up of known pathology (Table 1).

rule out serious pathology
detect and target/localize treatable causes
assure clinician and/or patient
monitor treatment and/or follow-up pathology

Table 1. Reasons for Imaging in Low Back Pain.

To Image or not to Image in Low Back Pain?

Acute Low Back Pain

Acute LBP is limited to 6 to 12 weeks in duration before it is called chronic. In general, imaging is not recommended in first episodes of acute low back pain without leg pain unless specific findings are present. These specific findings - so-called 'red flags' - are indicators of possible underlying serious disease (Table 2). In acute LBP these include trauma, cauda equina syndrome, progressive neurologic deficit and infection and/or malignancy.

Possible indications for imaging in acute LBP	Possible indications for imaging in chronic LBP
trauma	structural malformation
progressive neurologic deficit	onset <20 or >55 years
cauda equina syndrome	steroid use
spinal infection	non-mechanical pain
known malignancy	known malignacy
	systemic disease, unexplained weight loss, HIV
	sphincter or gait disturbances
	serious or progressive weakness

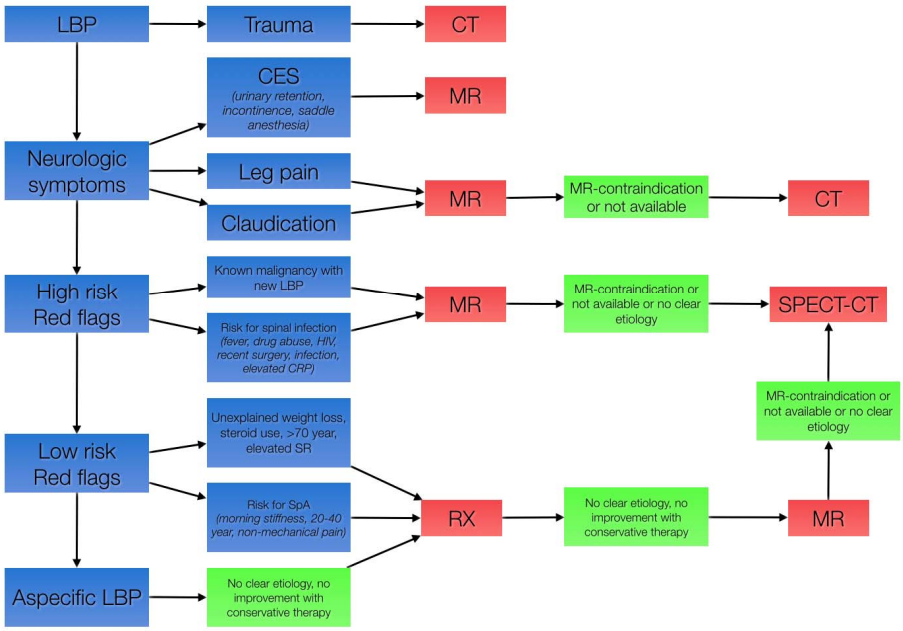
Table 2. Possible indications for imaging in Low Back Pain. Presence of any of these warrants further investigation with imaging.

Chronic Low Back Pain

Although the differential diagnosis is extensive, many cases of chronic low back pain have a biomechanical cause. Diagnostic imaging should be ordered only when necessary because of the high incidence of radiologic abnormalities in asymptomatic persons. Therefore, history and physical examination are important in distinguishing potential causes and identifying 'red flags' for more serious conditions. Note that in chronic LBP these red flags are more elaborate than in acute LBP. Presence of 'red flags' calls for imaging and an overview is listed in Table 2. Some conditions, listed at the bottom half of Table 2, warrant prompt MRI of the spine.

What is the Most Appropriate Imaging Technique?

The flowchart below is a comprehensive representation of what we already explained above. In this chart the most appropriate imaging technique for each situation is indicated:



Flowchart for Imaging in Low Back Pain.

In general we can state that CT is the preferred imaging modality in trauma, MR is the preferred technique in patients with (high risk for) serious pathology, and that in all other cases plain film is the first imaging technique but MR is added in a later stage in many cases.

Aspecific Low Back Pain

80 to 90% of cases of LBP are called aspecific because the anatomical origin of the pain remains elusive. Intervertebral discs, facet and sacroiliac joints and to a lesser degree ligaments and muscles can all play a role as pain generator in acute LBP. Although it is impossible to accurately assign LBP to a structural or functional correlate using anamnestic, clinical or imaging findings in all cases, imaging may suggest a possible pain generator in many cases.

I will discuss several imaging findings that are correlated with low back pain.

Intervertebral Disc Pathology

Intervertebral disc pathology is thought to be one of the causative factors of low back pain. Studies that demonstrate innervation to the intervertebral disk provide evidence that may account for instances of discogenic low back pain. It was revealed that innervation of the inner disk was observed only in painful disks, not in normal control disks. Based on these observations, nerve ingrowth into the inner disk may be a cause of nonspecific discogenic low back pain. MR imaging findings that correlate with painful discs on discography are those typical for disc degeneration, mainly signal loss of the disc on T2-WI, but also loss of disc height, the presence of a hyperintensity zone (HIZ) and Modic changes.

The hyperintensity zone

The hyperintensity zone (HIZ) is a localized region of high signal intensity on T2-WI within the annulus fibrosus. Histopathologically these lesions represent replacement of the normal lamellar structure by a disorganized, vascularized granulation tissue consisting of small round cells, fibroblasts, and newly formed blood vessels around tears that extend from the nucleus pulposus to the outer region of the annulus fibrosus. Originally the presence of a HIZ was strongly correlated with a painful disc on discography. This correlation has confirmed in multiple later studies, but was also questioned in a few other studies. In general, the association between an annular tear on MR images and low back pain is unclear.

Modic changes

Modic changes in the vertebral endplates adjoining a degenerative disc were first described in 1988. Modic et al. reported two types of changes: Modic type 1, histopathologically corresponding to vascular granulation tissue and Modic type 2 changes representing fatty degeneration. Later, Modic type 3 changes were added, representing bone sclerosis (Table 3). Some groups also use the term Modic type 0 for normal vertebral bone marrow. Modic type 1 changes are dark on T1-WI and bright on T2-WI, Modic type 2 changes are bright on both sequences and Modic type 3 changes are dark on both sequences.

Modic classification	T1-SI	T2-SI	Represents
I	–	+	Vascularized bone marrow and/or edema
II	+	+	Proliferation of fatty tissue
III	–	–	Sclerotic bone

Table 3. Modic changes according to MR signal intensity changes of the adjacent vertebral endplates.

In general Modic type 2 changes are the most frequent (60 … 90%), followed by type 1 changes (10 … 40%). Type 3 changes are rare. The prevalence of Modic changes in asymptomatic patients is reported between 0 and 10%, with Modic type 1 changes being very uncommon (<0,1%). The prevalence of Modic changes rises with age. In patients with LBP the prevalence of Modic changes is reported between 20 and 60%. Modic changes are a common finding in patients with non-specific LBP with a median prevalence of 43% and it is less common in non-clinical populations with a median prevalence of 6%. The reasons why Modic changes are associated with LBP are not known. The lumbar vertebral endplate contains immunoreactive nerves, and it has been reported that an increased number of tumor necrosis factor (TNF), immunoreactive nerve cells and fibres are present in endplates that have Modic changes, especially in type 1 changes.

Degenerative facet disease

Diagnosis of facet-mediated spinal pain is difficult. History and physical examination may suggest, but cannot confirm, the zygapophysial joint aka "facet" joint as the source of pain. Although radiologists are commonly asked by clinicians to determine the degree of the facet joint osteoarthritis, the published radiological investigations report no correlation between the clinical symptoms of low back pain and degenerative spinal changes observed on radiologic imaging studies. Specifically, the association between degenerative changes in the lumbar facet joints and symptomatic low back pain remains unclear and is a subject of ongoing debate.

Although imaging of joint morphology has not been proven helpful, the detection of inflammation may be more useful. Single photon emission tomography (SPECT) has shown a correlation between radionuclide uptake in the facet joints and response to intra-articular injections.

Magnetic resonance imaging is a non-invasive investigation that is not associated with exposure to ionizing radiation and provides excellent soft-tissue resolution. Recent studies showed a correlation between facet joint synovitis and the clinical pain syndrome. Moreover synovial abnormalities seem to correlate with SPECT findings.

How to Perform MR in Low Back Pain?

A basic MR examination of the lumbar spine includes at least sagittal and axial images. Among others, sagittal images clearly depict the conus medullaris, intervertebral discs and neural foramina, while axial images give a clear view of the vertebra and disc contour (changes).

T1-weighted images provide high contrast between the intervertebral disc (herniations) and the epidural fat tissue and the foraminal nerve root and fat tissue. T2-weighted images on the other hand give high contrast between CSF on the one hand and disc and nerve roots on the other hand. T2-weighted images also allow evaluation of the internal structure of the intervertebral disc and gradation of disc degeneration.

Some kind of fat saturation sequence should also be included in the standard lumbar imaging protocol. We prefer STIR imaging, because of the robust fat saturation, over spectral fatsat T2. STIR imaging is essential in evaluating inflammatory pathology including Modic changes and facet joint synovitis.

In the postoperative spine T1-weighted imaging after intravenous administration is compulsory in order to differentiate epidural fibrosis from recurrent disc herniation.

Imaging patients with metal implants such as pedicle screws or cages requires attention to artifact reduction. Preferably use TSE/FSE (turbo or fast spin echo) sequences with a high TSE factor (long echo train) and not SE or GRE (gradient echo). Shortening TE and widening bandwidth are obvious measures, but also use thin slices and avoid parallel imaging techniques. Some manufacturers include specific metal artifact reducing sequences (MARS).