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PRACTICE

RATIONAL IMAGING

Low back pain in primary care

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This series provides an update on the best use of different imaging methods for common or important clinical presentations. To suggest a topic, please email us at practice@bmj.com

A woman aged 71 with smoking related lung disease and frequent use of corticosteroids presented to clinic with acute severe low back pain. The pain began yesterday after she moved furniture in her apartment, is centrally located in the upper lumbar region without radiation to the legs, and is worse with movement. On examination, she has tenderness to palpation over the upper lumbar spine.

What is the next investigation?

Many observers argue that lumbar spine imaging is overused in developed countries because of a low yield of clinically useful findings, a high yield of misleading findings, radiation exposure (especially to the gonads), and costs. This is a particular concern in the United States, where imaging capacity is high, and spine specialists commonly have their own imaging facilities. These concerns are valid, despite the broad differential diagnosis of back pain, which includes not only degenerative changes but deformity, fracture, and underlying systemic diseases such as malignancy, infection, or ankylosing spondylitis. Though metastatic cancer might be the most common of these systemic conditions, its prevalence in primary care patients with back pain is less than 1%.[1]

In the absence of neurological symptoms, the main reason to consider early lumbar imaging is to identify serious underlying systemic disease or fractures. Fortunately, these are rare, though their prevalence varies with age, sex, and clinical presentation. In the case presented here, the patient's age, sex, smoking status, and use of corticosteroids render her at high risk for an osteoporotic vertebral compression fracture.[1] The acute onset, localized nature, and aggravation with movement are consistent with a diagnosis of fracture.

In the United Kingdom, the National Institute for Health and Care Excellence (NICE) recommends "consideration of MRI" when fracture is suspected.[2] Guidelines from the American College of Physicians recommend plain radiography for patients with risk factors for vertebral compression fracture but only after a therapeutic trial (table 1⇓).[3] In this case, because of multiple risk factors for fracture, a compromise would be early radiography, which could confirm the diagnosis, prompt appropriate treatment to reduce the risk of future fractures, and raise the possibility of treatment with calcitonin for acute pain.[4] Radiography confirmed the diagnosis of compression fracture (fig 1⇓).

Imaging for neurological symptoms

The presence of severe neurological symptoms, such as urinary retention, saddle anesthesia, or severe or progressive motor deficits would raise the possibility of massive disc herniation, tumor, or displaced fracture fragment causing cauda equina syndrome or compression of the cord. Guidelines in both the UK and the US suggest these rare findings are indications for advanced cross sectional imaging: magnetic resonance imaging (MRI) where available or computed tomography (CT) where it is not.[2 3 5]

Minor neurologic findings are more common. A herniated disc causing radiculopathy might result in symptoms of sciatica, limited straight leg raising, a missing deep tendon reflex, or mild foot weakness in dorsiflexion or plantar flexion. Spinal stenosis would be suspected in an older adult with radiating leg pain or pseudoclaudication.

In these circumstances, guidelines from the American College of Physicians (table 1⇓) recommend a one month trial of treatment before imaging because most patients with acute back pain and radiculopathy improve substantially in that interval without invasive interventions[6] and imaging would not alter

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Key points

- Imaging of the lumbar spine for low risk patients can be overused given its low yield of useful findings, high yield of misleading findings, and lack of proved benefit for outcome
- Radiography (with or without erythrocyte sedimentation rate) is often an appropriate initial test for suspected cancer, fracture, or inflammatory spondylopathy
- MRI is appropriate for patients with major neurologic deficits. It is also appropriate for those with a clinical picture of sciatica or stenosis who fail to improve with a therapeutic trial and are potential candidates for surgery or epidural steroids
- Patient histories of cancer, injection drug use, major trauma, or prolonged corticosteroid use are important "red flags" to prompt imaging; other individual red flags have weak likelihood ratios, and the full clinical picture should guide the ordering of lumbar images

initial management.[5] If patients have not improved after a month, and interventions such as surgery or epidural steroid injections are considered, advanced imaging is indicated (figs 2 and 3⇓⇓). The NICE guidelines do not refer to imaging for these milder neurologic findings

Risks of unnecessary imaging

Clinicians and patients alike might imagine no harm in a non-invasive imaging test. In the case of spine imaging, however, there is a substantial risk of uncovering irrelevant and misleading findings. For example, in a study of 98 MRIs from pain-free volunteers (mean age 42), only 36% had normal discs at all levels. Over half had a bulging disc, and 27% had a protruded disc. Annular fissures were found in 14% and facet arthropathy in 8%.[7] A prospective study of 200 individuals who initially had no back pain showed that imaging abnormalities often preceded development of back pain. Among the 25% who developed back pain over five years, most MRI findings were unchanged or even improved.[8] Plain radiography and computed tomography similarly show frequent "abnormalities" in pain-free individuals. Both a randomized trial[9] and observational studies[10] suggest that such findings can lead to more surgery and more aggressive treatment, without improvements in patient outcomes. In studies of geographic variations in care, rates of spinal surgery are higher where MRI rates are higher.[11]

Knowing about an imaging abnormality might have adverse effects on patient self perceptions and behavior. In a randomized trial, low risk patients who underwent plain lumbar radiography reported worse pain and overall health during follow-up than those who had no imaging. They also sought more medical care.[12] Similarly, in a trial of lumbar MRI, patients were randomized to receive the report or not. Although clinical outcomes were the same for the two groups, those who did not receive results reported greater improvements in general health.[13] Thus, spinal imaging in low risk patients might diminish self perceived health and drive unnecessary visits and surgery.

Radiation exposure is a concern for plain radiography and computed tomography. Unlike chest radiography, lumbar spine films result in substantial irradiation of the gonads, slightly increasing both mutagenesis and carcinogenesis. Computed tomography results in higher radiation exposure than radiography. In the US, an annual 2.2 million lumbar scans are projected to result in an additional 1200 future cases of cancer.[14] Because of reproductive concerns and the time required for cancer to develop, radiation risks are more important in younger than in older patients.

Impact of imaging on patient outcomes

The ultimate confirmation of the value of a diagnostic test is that it improves patient outcomes, presumably by guiding better treatment. Though randomized trials of diagnostic tests are rare, we identified six randomized trials of some form of lumbar spine imaging compared with usual care without imaging for low risk patients. In pooled analyses, the use of imaging was not associated with any advantage in pain relief or functional recovery, in either the short term (<3 months) or the longer term (6 months to a year).[15]

Strategies for selective ordering of lumbar images

Given the limitations of spinal imaging, several guidelines have recommended highly selective use. The NICE guideline recommends serial clinical review of the diagnosis; no radiography for non-specific low back pain; and consideration of MRI when malignancy, infection, fracture, cauda equina syndrome, or ankylosing spondylitis is suspected (table 1).[2] The clinical challenge is to decide when suspicion of these conditions is sufficiently high to warrant imaging.

Some studies and guidelines have proposed the use of "red flags" to guide selective ordering of lumbar images or to minimize the use of advanced imaging. Red flags are a history or findings on physical examination that suggest an increased probability of underlying systemic disease, fracture, or neurologic injury—conditions that might influence initial treatment. They typically include factors such as a history of cancer, a history of injecting drug use, advanced age (variously defined), major trauma, use of corticosteroids, and severe or progressive neurologic deficit. Some lists include a wider range of findings, such as limited straight leg raising, abnormal reflexes, spine tenderness, unexplained weight loss, and others.[1]

The prevalence of serious spine disorders is low and the sensitivity and specificity of most red flags modest (table 2⇓).[1 5 16] As a result, recent studies have highlighted the limited predictive value of most red flags and suggested that performing imaging with the presence of any red flag would result in unnecessarily high rates of imaging.[16] Observers have therefore suggested that use of imaging should be guided by the full clinical picture and observation over time, rather than by uncritical use of individual red flags.[17] Indeed, the predictive value of individual red flags varies substantially, and the presence of multiple red flags generates higher predictive values.[1 5] On the other hand, clinicians sometimes fail to assess major risk factors that should prompt early imaging, such as a history of cancer or injecting drug use, so some guidance seems appropriate.

One inexpensive strategy to augment the sensitivity and specificity of clinical assessment is the use of an inflammatory marker such as the erythrocyte sedimentation rate (ESR), which is often higher in patients with cancer, infections, or inflammatory spondylopathies. This has been incorporated into guidelines from the American College of Physicians (table 1).[2] Though the erythrocyte sedimentation rate is non-specific, its use in this context, combined with plain radiography, is mainly intended to help "rule out" underlying systemic disease without resorting to advanced imaging. A cost effectiveness analysis suggested that a reasonable strategy is to use advanced imaging

only for patients with a red flag plus either an erythrocyte sedimentation rate ≥50 mm/h or a positive result on radiography.[18]

Additional opportunities to reduce unnecessary spinal imaging include efforts to eliminate repeated testing, potentially with reminders of recent imaging through the use of electronic health records. Another strategy is to alert primary care clinicians about the dubious clinical importance of some degenerative findings on imaging by pointing out their high prevalence in pain-free individuals. A small observational study suggested that adding such a message to routine MRI reports could reduce the use of subsequent imaging tests.[19]

Factors promoting unnecessary spinal imaging

Many patients are eager for an explanation of their symptoms and expect imaging when they have back pain. In some studies, patients report higher satisfaction with care for back pain if imaging is performed than if it is not or if more advanced imaging is performed than radiography.[9 12] Studies of insurance claims in the US suggest that clinicians order earlier and more advanced imaging when they have financial incentives based on patient satisfaction questionnaires. Patient education strategies might mitigate the impact of delayed or no imaging on patient satisfaction.

Financial incentives are also important when there is high imaging capacity and referral to self owned imaging facilities. Both are concerns in the US, and the former might become increasingly important in the UK if commercialization of the National Health Service increases access to advanced imaging. Advanced imaging such as MRI offers a relatively high profit margin in the US. Finally, physicians are often concerned about legal liability if a serious diagnosis such as cancer or infection is delayed.

Outcome

The full clinical picture in this case prompted early radiography. The patient's L1 compression fracture was readily apparent on radiography, as was the suggestion of osteopenia. There was no indication of metastatic disease to suggest a pathologic fracture related to malignancy. The patient was treated with oral analgesics, and her symptoms were substantially improved at six weeks' follow-up. At that point, she was started on treatment with bisphosphonates, with the goal of reducing risk of further fracture.

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Tables

Table 1| Suggestions for imaging in patients with acute low back pain, from the American College of Physicians and the British National Institute for Health and Care Excellence (NICE)[2 3]

Imaging action	Suggestions for initial imaging
American College of Physicians guideline[3]	
Immediate imaging:	
Radiography* plus ESR	Major risk factors for cancer (history of cancer, multiple risk factors for cancer, strong clinical suspicion for cancer)
MRI	Risk factors for spinal infection (fever and history of injection drug use or recent infection)
	Symptoms or signs of cauda equina syndrome (new urinary retention, fecal incontinence, or saddle anesthesia)
	Severe neurologic deficits (progressive motor weakness or motor deficits at multiple neurologic levels)
Defer imaging after trial of treatment:	
Radiography with or without ESR	Weaker risk factors for cancer (unexplained weight loss or age >50 years)
	Risk factors for or signs of ankylosing spondylitis (morning stiffness that improves with exercise, alternating buttock pain, awakening because of back pain during second part of night, or younger age (age 20-40))
	Risk factors for vertebral compression fracture (history of osteoporosis, use of corticosteroids, significant trauma, or older age (>65 for women or >75 for men))
MRI	Signs and symptoms of radiculopathy (back pain with leg pain in L4, L5, or S1 nerve root distribution or positive result on straight leg raise or crossed straight let raise test) in patients who are candidates for surgery or epidural steroid injection
	Risk factors for or symptoms of spinal stenosis (radiating leg pain, older age, or pseudoclaudication) in patients who are candidates for surgery
No imaging	No criteria for immediate imaging and back pain improved or resolved after 1 month trial of treatment
	Previous spinal imaging with no change in clinical status
NICE guideline[2]	
	Keep diagnosis under review
	Do not offer x ray of the lumbar spine for the management of non-specific low back pain†
	Consider MRI when a diagnosis of spinal malignancy, infection, fracture, cauda equina syndrome or ankylosing spondylitis or another inflammatory disorder is suspected
	Only offer an MRI scan for non-specific low back pain within the context of a referral for an opinion on spinal fusion

ESR=erythrocyte sedimentation rate; MRI=magnetic resonance imaging.

*Consider MRI if initial imaging is negative but clinical suspicion for cancer remains high.

†NICE definition of non-specific low back pain: tension, soreness, and/or stiffness in the lower back region for which it is not possible to identify a specific cause of the pain. Several structures in the back, including the joints, discs, and connective tissues, may contribute to symptoms.

Table 2| Estimates of diagnostic performance for selected "red flag" clinical findings and selected diagnostic tests in detecting spinal malignancy or fracture. Spinal malignancy is the most common underlying systemic cause of back pain. Estimates are based on samples from primary care[1 5 16 18]

	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio
Red flags for cancer				
History of cancer	0.31	0.98	15.3	0.70
Age >50	0.77	0.71	2.7	0.32
Unexplained weight loss	0.15	0.94	2.6	0.90
Not improved after 1 month	0.31	0.90	3.0	0.77
Test accuracy for cancer				
ESR ≥20 mm/h	0.78	0.67	2.4	0.33
ESR ≥50 mm/h	0.56	0.97	18.7	0.45
Plain radiography	0.6	0.95-0.995	12-120	0.40-0.42
MRI	0.83-0.93	0.90-0.97	8.3-31	0.07-0.19
Red flags for spinal fracture				
Age >70	0.22-0.50	0.96	5.5-11.2	0.52-0.81
Use of corticosteroids	0.06-0.25	0.995	12-48	0.75-0.94
Significant trauma	0.25-0.30	0.85-0.98	2.0-10	0.77-0.82

ESR=erythrocyte sedimentation rate; MRI=magnetic resonance imaging.

Figures

Fig 1 Radiograph showing L1 compression fracture and suggestion of osteopenia but no evidence of metastatic disease

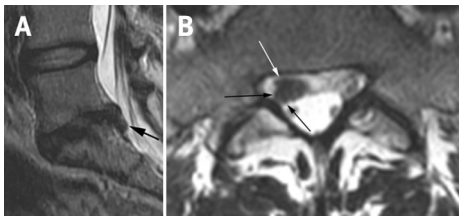

Fig 2 MRI from man in his 40s with persistent back and leg pain. Sagittal T2 weighted image shows a disc extrusion at L5-S1 extending inferiorly from level of interspace (black arrow) (a). Axial image shows that disc (long white arrow) is compressing right S1 nerve root (short gray arrows) in lateral recess (b)

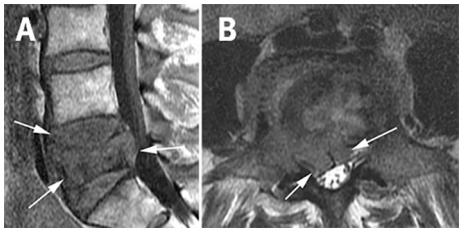

Fig 3 MRI from middle aged man with metastatic lung cancer, with new hip pain radiating to ankle. Sagittal T1-weighted image shows pathological fracture of L5 with hypointense tumor diffusely infiltrating the normal hyperintense marrow (white arrows) (a). Axial T2 weighted image shows extension of tumor posteriorly into lateral recess (white arrows) with presumptive compression of right S1 nerve root (b)