Diagnostic Tests for Low Back Disorders

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Objective: The aim of this study was to summarize evidence-based diagnostic guidelines for low back disorders. **Methods:** A comprehensive literature review was conducted. A total of 101 articles of high or moderate quality addressing low back disorders diagnostic evaluation met the inclusion criteria. Evidence-based recommendations were developed and graded from (A) to (C) in favor and against the specific diagnostic test, with (A) level having the highest quality body of literature. Expert consensus was employed for insufficient evidence (I) to develop consensus guidance. **Results:** Recommendations are given for these diagnostic tests: functional capacity evaluations, roentgenograms (x-rays), magnetic resonance imaging (MRI), computerized tomography, myelography, bone scans, single proton emission computed tomography, electromyography, surface electromyography, ultrasound, thermography, fluoroscopy, videofluoroscopy, lumbar discography, MRI discography, and myeloscopy. **Conclusion:** Diagnostic testing is not indicated for the majority of patients with low back pain.

Low back disorders are the second most frequent problems presented to health care providers. It is estimated that 60% to 80% of the general population will experience an episode of low back pain (LBP) during his or her lifetime.[1–3] The annual prevalence rate is between 25% and 60%.[4] LBP recurrence rates reportedly range from 24% to 80%.[5,6] Back injuries are among the most common causes of reported occupational disorders with an incidence rate of 20 per 10,000 full-time workers and an average of 7 days away from work per injury.[7] In addition, low back disorders are disproportionately expensive, accounting for 10% to 33% of workers' compensation costs.[8–10] Occupationally related back pain has a national direct annual cost estimate of $10.8 billion (US). However, this estimate is conservative as it does not include the indirect cost to employers who must rehire and retrain replacement workers, the loss of productivity, reduced quality work, administrative costs, and losses to the patient and patient's family (including productivity at home). Finally, it does not take into account those workers who do not file for disability, but nonetheless experience the effects of LBP.[11]

There are dozens of systematic reviews and guidelines that have been developed to address select elements of evaluation and treatment of LBP such as diagnostic imaging[12,13] and manipulation[14–16]; there also are a few that are broad in scope.[16–25] There was no recent guideline identified, nor any other guideline identified meeting current guidelines quality standards[26–29] and addressing detailed and comprehensive low back disorders evaluation and management.

GUIDELINE FOCUS

ACOEM's Low Back Disorders Guideline is designed to provide health care providers who are the primary target users of this guideline with evidence-based guidance on the evaluation and treatment of low back disorders, whether acute (up to 1 month duration), subacute (1 to 3 months' duration), chronic (>3 months' duration) Practice-Guidelines-Center/Guidelines-Methodology or postoperative. This guideline does not address several broad categories including congenital disorders or malignancies. It also does not address specific intraoperative procedures. This report is the first of three parts that summarizes findings for low back disorders, with this part focusing on the diagnostic evaluation sections from the ACOEM Low Back Disorders Guideline (2391 references). This report addresses the following questions from those addressed by the Evidence-based Practice Spine Panel:

- What evidence supports the initial assessment and diagnostic approach?
- What red flags signify serious underlying condition(s)?
- What diagnostic approaches and special studies identify clinical pathology?
- What is the evidence of work-relatedness for various diagnoses?

TARGET POPULATION

The primary target population is working-age adults, although the literature searches included articles addressing all adults. Thus, it is recognized that the principles may apply more broadly.

GUILDELINE DEVELOPMENT PROCESS

A detailed methodology document specifies evidence selection, scoring, incorporation of cost considerations, and formulation of recommendations.[30,31] Briefly, the aim is to identify the highest quality evidence on any given topic. Guidance was drafted using tables of evidence that abstracted the evidence. Draft text and tables were forwarded to the multidisciplinary Panel (Russell Travis [chair], Roger M. Belcourt, Ronald Donelson, Marjorie Eskay-Auerbach, Jill Galper, Michael Goertz, Scott Haldeman, Paul D. Hooper, James E. Lessenger, Tom Mayer, Kathryn L. Mueller, Donald R. Murphy, William G. Tellin, Michael S. Weiss, and panel consultant Cameron W. MacDonald). The Panel reviewed the evidence and finalized the text and recommendations.

EVIDENCE REVIEW AND GRADING

All evidence related to low back disorders in searching four databases was included in this guideline (PubMed, EBSCO, Google Scholar, and Cochrane). These comprehensive searches for evidence were performed through January 2018 to help ensure complete study capture. There

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was no limit on the year of publication. Search terms for this report are available at: https://acoem.org/Practice-Resources/Practice-Guidelines-Center/Guidelines-Methodology. Reference lists of included articles were reviewed for inclusion. All included studies were scored for quality.[30] Articles scoring moderate or high quality were included.[30]

The search strategies retrieved a total of 9972 articles, which were screened, with all potentially relevant study abstracts reviewed and evaluated against specified inclusion and exclusion criteria. A total of 116 articles met the inclusion criteria and were included in these guidelines. Remaining evidence included in these guidelines was received from the Panel members and a review of references in the included articles.

Articles meeting the inclusion criteria were critically appraised and scored for quality. Articles scoring moderate or high quality were included.[30] A total of 101 were of high or moderate quality addressing low back disorders diagnostic evaluation. Evidence-based recommendations were developed and graded from (A) to (C) in favor and against the specific diagnostic test, with (A) level recommendations having the highest quality body of literature. Expert consensus was employed for insufficient evidence (I) to develop consensus guidance. Recommendations and evidence tables were reviewed and amended by the multidisciplinary Panel. This guideline achieved 100% Panel agreement for all developed guidance.

COMMENTS AND MODIFICATION

Guidance was developed with sufficient detail to facilitate assessment of compliance (Institute of Medicine [IOM])[27] and auditing/monitoring (Appraisal of Guidelines for Research and Evaluation [AGREE][28]). Alternative options to manage conditions are provided in other ACOEM guidelines when comparative trials are available.[32–40] The guidance adhered to all AGREE,[28] IOM,[27] AMSTAR,[29] and GRADE[26] criteria.[30] In accordance with the IOM's Trustworthy Guidelines, this guideline underwent external peer review by 13 medical/health professional societies and at least 18 individual external reviewers, and subsequent revisions to the guidance, and detailed records of the peer review processes are kept, including responses to external peer reviewers.[27]

Separate reports on this guideline's findings concerning medical management including noninterventional therapies and for injection therapies, surgery and rehabilitation are available.

The Evidence-based Practice Spine Panel and the Research Team have complete editorial independence from ACOEM and Reed Group, which have not influenced the guideline. The literature is continuously monitored and formally appraised for evidence that would materially affect this guidance. This guideline is planned to be comprehensively updated at least every 5 years or more frequently should evidence require it. All treatment recommendations are guidance based on synthesis of the evidence plus expert consensus. These are recommendations for practitioners, and decisions to adopt a particular course of action must be made by trained practitioners on the basis of available resources and the particular circumstances presented by the individual patient.

CLINICAL RECOMMENDATIONS

Comprehensive History and Physical Examination

No quality studies assess the utility and/or components of a history and physical examination. Nevertheless, the Panel's consensus recommendation is that a careful history and physical examination is naturally important for appropriate evaluation and diagnosis (Table 1), as well as to develop a good therapeutic relationship which is of importance for optimizing outcomes. The initial assessment of LBP has a unique emphasis on 'ruling out' serious underlying conditions (eg, kidney stone, infection, cancer, fracture). This ruling out process primarily relies upon the identification of 'red flags.'[41]

Relatively common red flags for LBP in employed populations include trauma (eg, falls, significant motor vehicle crashes), history of cancer, immunosuppression, progressive neurological deficit, renal colic, and history of urinary tract infections. The absence of red flags and conditions generally rules out the need for special studies, referral, or inpatient care during the first 4 to 6 weeks. During this time, spontaneous recovery is expected, particularly if any significant workplace factors are mitigated.[17] A minority of LBP-related cases are due to radiculopathy and those too typically resolve with noninterventional management.

A comprehensive evaluation and documentation include a history, prior treatment, vocation, avocational activities, current functional level, medical history, family history, social history including substance(s) use (tobacco, alcohol, and illicit substances), review of systems, laboratory testing, and imaging studies.

An evaluation using repeated end-range testing while monitoring for patterns of pain response determines the presence or absence of two common clinical findings, directional preference and pain centralization. The presumptive pain generator's directional preference is that single direction of testing that results in the pain centralizing, abolishing, or both. ''Pain centralization'' occurs when pain referred or radiating away from the spine retreats back

TABLE 1. Ability of Various Techniques to Identify and Define Low Back Pathology and Sequelae

Technique	Low Back Pain	Disc Herniation/Protrusion	Cauda Equina Syndrome	Spinal Stenosis	Postlaminectomy Syndrome
History	++++	+ + +	+ + +	+ + +	+ + +
Physical examination	+ +	+ + +	+ + + +	+ +	+ +
Laboratory studies	0	0	0	0	0
Imaging studies					
Radiography*	0	+	+	+	+
Computerized tomography (CT)*,†	0	+ + +	+ + +	+ + +	+ +
Magnetic resonance imaging (MRI))*,†	0	+ + + +	+ + + +	+ + +	+ + + +
Electromyography (EMG), sensory evoked potentials (SEPs)‡	0	+ + +	0/+	+ +	+

Number of plus signs indicates relative ability of technique to identify or define pathology.
*Risk of complications (eg, infection, radiation) highest for myeloCT, second highest for myelography, and relatively less for bone scan, radiography, and CT.
†False-positive results in up to 30% of people over age 30 who do not have symptoms and may be over 50% in those over age 40.
‡EMG is generally unhelpful in the first month of symptoms other than to document prior disease or injury status.

toward or to the midline in response to a single direction spinal testing. Those patterns are typically assessed during end-range loading tests in various directions of spinal bending performed by the patient while both standing and recumbent. These findings characterize a large LBP subgroup for whom directional exercises appear to provide superior outcomes.[42–49]

Diagnoses

Most LBP cases, whether acute or chronic, have pain in the lumbar spine. Pain may be experienced in the lower extremity, although spine pain predominates in LBP cases. The unique aspect of the diagnostic approach for LBP is that the vast majority of cases, estimated at over 95% in most employed populations,[3,50–52] have no definable pathophysiological abnormality. Some practitioners refer to these LBP patients as having incurred ''sprains'' and/or ''strains''; however, these labels are not ideal as there is no identifiable ligament or myotendinous injury. The use of those terms also confuses the proper use of those diagnoses elsewhere in the body, becomes problematic in determination of work-relatedness, and misdirects patients on the value of activity for early functional recovery. These patients are best termed as having the most precise diagnosis possible, that is, the symptom of LBP.

Pain that is solely or mostly traveling in a posterior thigh and calf generally, but not always, signifies radiculopathy, particularly when the radicular pain in the extremity substantially exceeds that in the back or is the sole symptom. As pain predominates among radicular pain patients, a history of paresthesias will generally require specific, focused questions to elicit.

Associated Factors and Risk Factors for Nonspecific LBP

There are many nonoccupational factors that have been associated with LBP. The most consistent and strongest is a prior history of LBP, which is one of the factors also confirmed in prospective studies.[53–65] Aging has been associated with LBP in some studies,[66–69] but many do not support a relationship with nonspecific LBP in contrast with degenerative spine conditions. Instead, aging has been consistently associated with degenerative back disorders.[4,70–72] Additional reported risk factors for LBP include smoking,[62,67,73–75] obesity,[56,62,63,66,67,69,73–92] height,[91] high triglycerides,[93] hypertension,[75] genetic factors,[72,94–96] poor general health,[97,98] poor sleep,[62,73,99] pain-related fear,[64,97] prolonged driving,[62] deconditioning,[100] and physical inactivity or lack of exercise.[62,73,75,101] A pattern of increased risk associated with cardiovascular risk factors and cardiovascular risk factor scores has been observed.[75] A U-shaped relationship between physical activity and risk of LBP has been reported in two epidemiological studies.[51,102]

A number of physical factors are reported to be associated with LBP, although most of the evidence is from retrospective studies without measured job factors. Yet, recent data from a prospective cohort study with measured job physical factors have supported high lifting forces, as measured by the Cumulative Lifting Index, as associated with increased risk of LBP.[54,55,58] Cross-sectional studies have reported mostly unconfirmed associations between LBP and heavy physical work (particularly lifting heavy objects or lifting large and awkward objects),[61,62,67,73,79,98,103–110] lifting weights above shoulder level,[108] carrying,[69,109] trunk in a bent or twisted posture,[64,69,73] prolonged or highly repeated bending, inability to change posture regularly,[64,111] standing and walking,[112] frequent reaching or forceful pushing or pulling,[108,113] kneeling,[108] or squatting.[108] Housework was shown to be a risk factor in a prospective cohort study.[54,58] Prolonged sitting and whole body vibration[70,73,114–116] are also suggested by some to be contributors. Work with scaffolding is a reported association.[98] These activities are not exclusive to job functions and should be reviewed as they pertain to nonoccupational activities as well. Unaccustomed physically demanding work (or sports or hobbies), another probable risk factor, is under recognized and may be fairly potent.

Until recently, prospective data supporting work-relatedness of LBP were limited. Recent data suggest increased risk of LBP as assessed by the Cumulative Lifting Index that was derived from the Revised National Institute for Occupational Safety and Health (NIOSH) Lifting Equation.[54,55,58,117] Yet, support for degenerative disorders remains unsubstantiated.

Reduced lifting programs have been found to be successful at reducing risk of LBP in settings of manual patient transfers,[118–123] but not in most other settings. Programs have been ineffective for stress management, shoe inserts, insoles, back supports.[124] Lifting advice and training also do not appear effective.[125]

It has also been theorized that these ''stressors'' do not cause back disorders. Rather, when a back disorder arises in an individual who does heavy physical work, the work is then more difficult to accomplish and the individual is more likely to file a workers' compensation claim. This is compared to the sedentary worker who develops back pain and may continue to perform work though more carefully (reporting bias).[126,127]

Psychosocial factors, both occupational and nonoccupational, also have been reportedly associated with back disorders.[128] These include task enjoyment, monotony,[108] mental stress,[73,108] work stress,[67] job dissatisfaction,[54,129] life dissatisfaction,[73] high demand/low control,[98,99] low supervisor support,[99] low coworker support,[99] and social isolation.[62] Psychiatric symptoms such as anxiety, depression,[54,58,61,130] low energy,[62] emotional problems,[62] and somatization are all apparent risk factors. Providers with high fear avoidant beliefs also may contribute by prescribing more sick leave, bed rest, and less return to normal function.[131,132] Many cases of LBP in the general population are idiopathic and the mechanism of LBP has not yet been elucidated.

Associations With Degenerative Spine Conditions Including Sciatica

There are no quality studies of degenerative spine conditions including radiculopathy, and thus no true job physical risk factors are known. There is a poor correlation between LBP and degenerative findings on imaging studies,[4] as well as between LBP and MRI findings of disc protrusion, nerve root displacement or compression, disc degeneration, and high intensity zone.[133] The prevalence of nerve root contact is 11% to 23% and for displacement and/or compression 2% to 5%. Overall prevalence of disc degeneration in asymptomatic people is 54%, with a strong relationship with age.[133] Prevalence of high-intensity zone (HIZ) or annular fissure overall is 28% to 56%.[134]

Risk factors for degenerative back conditions that include spinal stenosis are not well defined compared with those for nonspecific LBP. Nutrient vessels disappear to the disc, requiring diffusion.[135] This may provide a mechanistic explanation for cardiovascular disease risk factor impacts, particularly on degenerative spine disorders.[75] Degenerative disc changes have been well linked with inheritance,[72,94–96,136–139] and genetic influences on the outcomes of spine surgery have also been reported.[140,141] Available epidemiological studies suggest the risk factors for degenerative conditions include aging,[4,70,71] male sex,[71,142–144] obesity,[71] heredity,[4] and systemic arthrosis.[145] Reported risks for spondylolysis include increasing age and male sex.[71] Risks for degenerative spondylolisthesis include age and female sex.[71] Risks for facet joint arthritis are increasing age and obesity.[71] A trend towards greater spinal stenosis in those with a BMI $>30\,kg/m^2$ has been reported,[71] but that study is likely underpowered. There are no quality ergonomic-epidemiological studies reported for

degenerative spine conditions and job physical factors.

There are no proven risk factors for radiculopathy as it is a relatively rare event and quality epidemiological studies have not been reported. However, heavy lifting and activities that substantially increase the intradiscal pressures are theorized factors. Prolonged whole-body vibration such as prolonged driving is a reported, but disputed factor.[114] Aside from age, smoking appears to be a factor. Spondylolisthesis is most often degenerative in nature. There are acute trauma-related cases in which causal analysis is straightforward and centers on whether the inciting trauma was in the context of work and that the magnitude of the event was sufficient to truly be an acute traumatic event.

There are no quality epidemiological studies that support theories that degenerative spondylolisthesis, spinal stenosis, degenerative facet disease, or sciatica/radiculopathy are occupational conditions. However, there is a biomechanical theory that physical factors may contribute through degenerative disease in the discs with resulting theoretically altered biomechanical forces in the facets resulting in or accelerating degenerative facet osteoarthrosis. Yet, there also is evidence that these conditions may have a genetic basis.[146,147]

Special Studies and Diagnostic and Treatment Considerations

Detailed discussion of various imaging studies follows this section. Lumbar spine x-rays are not recommended in patients with LBP in the absence of red flags for serious spinal pathology within the first 4 to 6 weeks. Among patients with evidence of radiculopathy, imaging in the acute pain setting is also not recommended as the natural history is for such problems to resolve with conservative care. Table 1 provides a general comparison of the abilities of different techniques to identify physiologic insult and define anatomic defects. An imaging study may be appropriate for a patient whose limitations due to consistent symptoms have persisted for 1 month or more to further evaluate the possibility of potentially serious pathology such as a tumor or with progressive neurologic deficit(s).

Diagnostic Testing and Other Testing

Diagnostic tests can be categorized into three broad categories: (1) anatomical, (2) functional, and (3) physiological. Anatomical tests help to define anatomy and include roentgenograms, magnetic resonance imaging (MRI), bone scans, computerized tomography (CT), and myelograms. Functional tests include those that assess voluntary lifting, pushing, or pulling capacities. Physiological tests include electromyography (EMG). Tests such as discography attempt to bridge the gap between two of these testing domains and are organizationally included in this document in one domain. In considering which test to order, it is important to be able to address two key questions:

1. What is the specific question to be addressed?
2. What will be done with the results?

The first question must be clearly addressed and the second must result in an unequivocal answer used for a decision point with the results having a significant probability of altering the clinical management. Otherwise, the test is almost never indicated.

The operant characteristics of the test being ordered are critical to the proper interpretation of the results. For example, lumbosacral spine MRIs are more likely to be ''abnormal'' by age 40 in normal individuals (show normal aging changes), and herniated discs are not infrequently found in screening studies of asymptomatic teenagers and young adults.[134,148–166] The pretest probability of disease, determined by a careful clinical evaluation, is critical to address the probability that the abnormality identified on the image is actually causing the individual's symptoms. At present, there is not one type of imaging method that shows a clear advantage over others. Generally, MRI is superior for imaging soft tissue including intervertebral disc herniations.

There are many additional diagnostic tests possible for the evaluation of LBP and spinal conditions. In the absence of moderate- to high-quality studies, other tests are *Not Recommended, Insufficient Evidence (I), Low Confidence*.[30]

FUNCTIONAL CAPACITY EVALUATIONS

Functional capacity evaluations (FCEs) consist of a comprehensive battery of performance-based tests to attempt to provide the treating physician with detailed information on an individual's ability for work and activities of daily living.[167–190] As FCEs are performance-based tests, participation with full, maximal efforts is critical. FCE evaluators attempt to determine physical effort based on a combination of physiological and biomechanical factors and movement/performance consistency. Thus, FCE testing is best performed by the treating therapist during the episode of care when the results can be compared with prior observations, inform treatment, help assess progress, and provide useful information about physical function. However, most FCEs are performed on 1 day. Of the 781 articles found in this systematic review, five articles were initially included of which three are moderate-quality studies incorporated into this analysis[191–193] and there are two low-quality studies.[194,195] These studies were 1-day FCEs performed outside the clinical context. The correlation between pain ratings and functional abilities is weak.[196–202] Studies suggest FCEs are unable to predict safe re-entry to the workplace following rehabilitation of work-related back pain/injury,[170,203,204] yet as return to work includes psychosocial and environmental factors, the inability to predict return to work may be unsurprising. As reliability and validity have not been proven, FCEs should be regarded as demonstrating what a patient was willing to do. In a prospective cohort study of 1438 consecutive work-related back patients, all underwent an FCE before return to work. In the control group, the FCE was used to write return-to-work guidelines, whereas in the study group it was ignored and the worker was returned usually to full duty. Ignoring the FCE improved outcome.[205]

FCEs are a recommended option for evaluation of disabling chronic LBP where the information may be helpful to attempt to objectify worker capability, function, motivation, and effort vis-à-vis either a specific job or general job requirements (*Recommended, Insufficient Evidence (I), Moderate Confidence*). There are circumstances where a patient is not progressing as anticipated at 6 to 8 weeks and an FCE can evaluate functional status and patient performance to match performance to specific job demands, particularly in instances where those demands are medium to heavy. That said, functional testing is recommended to be performed as a routine aspect of physical and occupational therapy which should obviate the need for a full day FCE. There is no recommendation for or against the use of FCEs for chronic stable LBP or after completion of postoperative recovery among those able to return to work (*No Recommendation, Insufficient Evidence (I), Low Confidence*). Functional capacity evaluations are not recommended for evaluation of acute LBP, acute or subacute radicular syndromes, or postsurgical back pain problems within the first 12 weeks of the postoperative period (*Not Recommended, Insufficient Evidence (I), High Confidence*).

ROENTGENOGRAMS (X-RAYS)

X-rays are commonly utilized for evaluation of LBP, particularly that which is chronic, persistent and accompanied by red flags or trauma[12,206] Similar to most

diagnostic studies, MRI is usually considered the gold standard comparison. There are five quality studies incorporated into the recommendation.[207–210] In general, routine x-ray is not recommended for acute nonspecific LBP (*Moderately Not Recommended (B), High Confidence*) but is recommended in the setting of red flags[207,209–212] where the acute LBP could be due to fracture, neoplasia, infection, or systemic illness, where subacute or chronic LBP is not improved as a means of ruling out other conditions (*Recommended, Insufficient Evidence (I), High Confidence*). Flexion and extension views are recommended for evaluating symptomatic spondylolisthesis (chronic, severe mechanical pain suspected as an instability), in which there is consideration for surgery or other invasive treatment or occasionally in the setting of trauma (*Recommended, Insufficient Evidence (I), Moderate Confidence*).

MAGNETIC RESONANCE IMAGING

MRI has been evaluated in 8 high-quality[150,213–219] and 30 moderate-quality[155,161,164,220–246] studies. The sensitivity and specificity of CT or MRI are challenging to define as they require a ''gold standard'' that is difficult to define in back pain because the final diagnosis often is based on the same imaging modality being tested; therefore, these clinical studies may be prone to incorporation bias, artificially inflating the sensitivity and specificity with some assuming MRI has 100% sensitivity and specificity.

Open MRIs have lower resolution and are not recommended other than when the patient's weight exceeds the closed MRI unit's specifications or suffers from claustrophobia that is not sufficiently alleviated with a preprocedure low-dose anxiolytic. Standing MRI units are designed to evaluate the discs and spine under usual conditions of axial loading and can be used in other positions. Magnets are typically weaker than conventional MRI, resulting in lower resolution. There are currently no quality studies on which to recommend standing MRI for uses outside of research settings, and interpretation of normal findings of increased disc bulging with standing are unclear, therefore standing or weight-bearing MRI is not recommended for back or radicular pain syndrome conditions (*Not Recommended, Insufficient Evidence (I), Moderate Confidence*).

MRI is recommended for patients with acute LBP during the first 6 weeks for evaluating progressive neurologic deficit, cauda equina syndrome, history of neoplasia (cancer), persistent fever plus elevated erythrocyte sedimentation rate without other infectious source, or atypical presentation, for example, clinical picture suggests multiple nerve root involvement (*Recommended, Insufficient Evidence (I), High Confidence*). MRI is moderately not recommended for acute radicular pain syndromes in the first 6 weeks unless the problems are severe and not trending towards improvement assuming the MRI confirms ongoing nerve root compression consistent with clinical examination and surgery is being considered. Repeat MRI imaging without significant clinical change in symptoms and/or signs, such as development of neurological deficit, is also not recommended (*Moderately Not Recommended (B), Moderate Confidence*).

MRI is moderately recommended for patients with subacute or chronic radicular pain syndromes lasting at least 4 to 6 weeks in whom the symptoms are not trending towards improvement and prompt surgery is being considered, assuming the MRI confirms a nerve root compression consistent with clinical examination. In cases where an epidural glucocorticosteroid injection is being considered for temporary relief of acute or subacute radiculopathy, MRI at 3 to 4 weeks (before the epidural steroid injection) may be reasonable (*Moderately Recommended (B), Moderate Confidence*).

MRI is recommended for selecting chronic LBP patients to rule out concurrent pathology unrelated to injury. This is not recommended before 3 months and only after other treatment modalities (including NSAIDs, aerobic exercise, and directional preference exercises) have failed (*Recommended, Insufficient Evidence (I), Moderate Confidence*). MRI is not recommended for evaluation of acute, subacute, or nearly all chronic LBP cases. MRI is indicated for discrete, potentially surgically treatable disorders such as radiculopathy, spondylolisthesis, and spinal stenosis.

COMPUTED TOMOGRAPHY

CT is primarily used to define fractures not visible on plain x-rays or when MRI is unavailable or contraindicated (especially for implanted ferrous device).[247] Due to the greater soft tissue contrast of MRIs, there is less current need for CT.[12,248] Yet, CT is widely thought to be sufficient to evaluate most patients with suspected disc herniations even though it is not as successful for soft tissue imaging.[249–251] There are four high-[252–255] and four moderate-quality[256–259] evaluating CT utility.

Routine CT is not recommended for acute, subacute, or chronic nonspecific LBP, or for radicular pain syndromes (*Not Recommended (C), High Confidence*). CT is, however, recommended for patients with acute or subacute radicular pain syndrome who failed to improve within 4 to 6 weeks and if there is consideration for an epidural glucocorticoid injection or surgical discectomy (see Epidural Steroid Injection). If there is strong consideration for surgery, then CT myelography should be considered instead of CT alone (*Recommended (C), Moderate Confidence*). If there is a contraindication to MRI and surgery is considered moderate to high probability, then CT myelography is a consideration instead of CT followed by another CT with myelography.

MYELOGRAPHY (INCLUDING CT MYELOGRAPHY AND MRI MYELOGRAPHY)

Myelography is the injection of a radiocontrast media into the thecal sac with subsequent imaging and was historically combined with standard roentgenograms as the most common method to diagnose herniated discs, spinal stenosis, or other forms of neurological compromise.[260–263] It was subsequently paired with CT (CT myelography) or rarely MRI (MRI myelography). However, it has been almost completely replaced by MRI that produces superior resolution of images. Consequently, there may be little use for myelography,[264] though many spine surgeons use CT myelography to help with surgical decision-making in cases in which MRI is equivocal or not possible. There are two high-[213,214] and two moderate-quality[265,266] studies. Myelography is recommended in uncommon situations, such as contraindications for MRI such as implanted metal that preclude MRI, equivocal findings of disc herniation on MRI suspected of being false positives, spinal stenosis, and/or a postsurgical situation that requires myelography (*Recommended, Insufficient Evidence (I), High Confidence*).

BONE SCANS

Bone scans show increased radioactive uptake and are most commonly used for evaluating many types of metastases,[267–269] infection, inflammatory arthropathies, occult fractures,[270–272] or other significant bone trauma.[273] There are no quality studies evaluating bone scans for diagnosis of typical occupational LBP patients. Reported sensitivity and specificity were not satisfactory for evaluating chronic LBP patients, and the population studied was felt to be too small to develop normative values.[274] Although not used for the evaluation of most LBP, it is a good diagnostic test for specific situations, including evaluations of suspected metastases, infected bone (osteomyelitis), inflammatory arthropathies, and trauma (fractures). Aside from specific indications which involve a minority of LBP patients,

the routine use of bone scanning is not recommended in diagnosing LBP (*Not Recommended, Insufficient Evidence (I), High Confidence*).

SINGLE PROTON EMISSION COMPUTED TOMOGRAPHY

Single proton emission computed tomography (SPECT) is a three-dimensional imaging technique that, for LBP issues, has been primarily used for the diagnosis of inflammatory arthropathies, for example, ankylosing spondylitis affecting the SI joints and other structures which are difficult to image.[275–282] There is one high-[283] and four moderate-quality[284–287] studies, but no quality evidence with patient-related outcomes that SPECT is helpful in improving care of acute, subacute, or chronic LBP, or radicular pain syndromes or other LBP-related conditions. However, one study found SPECT helpful in evaluating patients with inflammatory arthropathies, particularly if there are concerns about the SI joints.[288] Some data suggest SPECT may outperform bone scanning. Additional studies are needed to determine if SPECT adds something to the diagnosis, treatment and outcomes beyond that obtained by a careful history, physical examination, plain x-rays, and clinical impression before it can be recommended for evaluating facet arthropathies. SPECT is not currently recommended for LBP and/or related disorders (*Not Recommended, Insufficient Evidence (I), Low Confidence*).

ELECTROMYOGRAPHY

Among spine patients, EMG has been used primarily to evaluate radiculopathy.[289] As imaging studies (especially CT and MRI) have progressed, the need for EMG has declined. However, EMG remains helpful in certain situations. Needle EMG may help determine if radiculopathy and/or spinal stenosis is present and can help address acuity.[290] These include ongoing pain suspected to be of neurological origin, but without clear neurological compromise on imaging study. Electrodiagnostic studies, which must include needle EMG, are recommended where a CT or MRI is equivocal and there is ongoing pain that raises questions about whether there may be a neurological compromise that may be identifiable (ie, leg symptoms consistent with radiculopathy, spinal stenosis, peripheral neuropathy, etc.).[290–297] Also, may be helpful for evaluation of chronicity and/or aggravation of a preexisting problem (*Moderately Recommended, Evidence (B), High Confidence*). Electrodiagnostic studies are not recommended for patients with acute, subacute, or chronic LBP who do not have significant leg pain or numbness (*Not Recommended, Evidence (C), Moderate Confidence*). Electrodiagnostic studies are recommended for patients with subacute or chronic LBP highly suspicious for lumbar spinal stenosis when MRI findings may be negative (*Moderately Recommended (B), High Confidence*).

SURFACE ELECTROMYOGRAPHY

Surface electromyography (sEMG) has been used to diagnose LBP[298–314] and involves the recording of summated muscle electrical activity by skin electrodes (such as those used in an electrocardiogram or EKG). There are four moderate-quality studies incorporated into this analysis[313,315–317] and no quality evidence of diagnostic efficacy, and thus, is not recommended to diagnose LBP (*Not Recommended, Insufficient Evidence (I), High Confidence*).

ULTRASOUND (DIAGNOSTIC)

Ultrasound is seldom used for diagnostic purposes in the spine other than for unusual specific purposes such as detection and guided drainage of superficial abscesses.[318–324] There is one high-[320] and one moderate-quality[325]study showing no diagnostic efficacy and thus, it is not recommended for diagnosing LBP (*Not Recommended, Insufficient Evidence (I), High Confidence*). For most situations, CT and MRI are superior imaging techniques.

THERMOGRAPHY

Thermography has been used to assess LBP and radicular pain syndromes and other conditions.[326] There are no quality studies but two low quality studies using thermography,[327] and in the absence of quality evidence of efficacy, thermography is not recommended for diagnosing acute, subacute or chronic LBP or radicular pain (*Not Recommended, Insufficient Evidence (I), Moderate Confidence*).

FLUOROSCOPY

Fluoroscopy has been used for evaluation of LBP. Although used for guided procedures, there are no recent quality studies using fluoroscopy to evaluate either LBP or radicular pain. There are no evidence-based indications for this technique and is not recommended for evaluating acute, subacute or chronic LBP (*Not Recommended, Insufficient Evidence (I), Moderate Confidence*).

VIDEOFLUOROSCOPY

Videofluoroscopy has been used for evaluation of LBP, particularly searching for possible spinal instability. There are two low-quality studies. There are no quality studies demonstrating improved clinical outcomes and, therefore, videofluoroscopy for the assessment of acute, subacute, or chronic LBP is not recommended (*Not Recommended, Insufficient Evidence (I), Moderate Confidence*).

LUMBAR DISCOGRAPHY

Discography attempts to determine if chronic spinal pain is caused by disc pathology. Discography is typically used in patients with chronic spinal pain without significant leg pain, as MRI and/or CT provide adequate anatomic information for surgical decisions on decompressive surgery for patients with significant radiculopathy. However, discography is not standardized, which complicates the evaluation of the studies. There are 2 high-[328–330] and 22 moderate-quality[331–352] studies, and a systematic review[353] all of which suggest low positive predictive value and thus, discography, either performed as a solitary test or when paired with imaging (eg, MRI), is moderately not recommended for acute, subacute, or chronic LBP or radicular pain syndromes (*Strongly Not Recommended (A), High Confidence*).

MRI DISCOGRAPHY

MRI is sometimes paired with discography for evaluation of the intervertebral discs.[337–339,342,345] There are five moderate-quality studies incorporated, but no quality evidence showing discography with MRI improves outcomes with herniated discs, and, therefore, it is not recommended for evaluating herniated discs (*Not Recommended (C), Moderate Confidence*).

MYELOSCOPY

Myeloscopy is minimally invasive and may theoretically be used solely for diagnostic purposes but is most often performed in conjunction with adhesiolysis. There are three moderate-quality studies,[354–356] but there are no quality controlled studies with improvement in large scale, medium- to long-term studies.[357,358] Myeloscopy is an invasive study with potential complications, is costly, without quality evidence of efficacy, and is not recommended for diagnosing acute, subacute, or chronic LBP, spinal stenosis, radicular pain syndromes, or postsurgical back pain (*Not Recommended, Insufficient Evidence (I), Low Confidence*).

CONCLUSION

Diagnostic testing is not indicated for the vast majority of LBP patients. Some evidence suggests imaging may increase medicalization, and thus unnecessary additional testing, treatment, and resultant delayed recovery. Simple diagnostic tests likely have the potential to significantly increase adverse effects. Patients with red

flags, trauma, persistence despite treatment, progressive neurological deficits, and surgical indications are examples of exceptions to the rule of avoiding testing of most patients.

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