CLINICAL REVIEW

Early Diagnostic Evaluation of Low Back Pain

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BACK PAIN ranks second only to upper respiratory tract complaints as a symptomatic reason for visits to office-based physicians,[1] and seventh as a reason for visits to internists.[2] At least in some settings, fewer than 2% of these patients need surgery.

Since an earlier review,[3] several important findings have emerged concerning the diagnostic evaluation of low back pain. While much of the direct cost of treating patients who have back pain is related to diagnostic tests, recent data suggest that selective parsimonious testing may be appropriate, especially in primary care. This conclusion has emerged as the roles of the clinical examination and plain radiography have been refined and clarified.

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DIAGNOSTIC CONSIDERATIONS

Differential Diagnosis

Diagnostic nosology for the causes of back pain remains unstandardized. As suggested in Table 1, the causes can be broadly categorized as "mechanical" spine disorders, non-mechanical spine disorders, and visceral diseases resulting in back pain. The non-mechanical spine disorders are often systemic, including neoplastic, infectious, and inflammatory conditions.

The mechanical causes of pain may be considered together because they do not have a primary inflammatory or neoplastic component (although inflammation may occur), and because the initial therapies for most are similar. Pain may arise from injuries to a host of innervated structures in the spine, including the anterior and posterior longitudinal ligaments, the ligamentum flavum, interspinous ligaments, facet joint synovium, vertebral periosteum, paravertebral muscles, a variety of blood vessels, and the nerve roots. It is usually impossible to distinguish among these clinically, so they are often grouped as "low back strain."

TABLE 1

Differential Diagnosis of Low Back Pain

Mechanical Low Back Pain	Non-mechanical Spine Disease	Visceral Disease
Lumbar strain	Neoplasia	Pelvic organs
Degenerative disease	Multiple myeloma	Prostatitis
Discs (spondylosis)	Metastatic carcinoma	Endometriosis
?Facet joints	Lymphoma and leukemia	Chronic pelvic inflammatory disease
Spondylolisthesis	Spinal cord tumors	Renal disease
Herniated disc	Retroperitoneal tumors	Nephrolithiasis
Spinal stenosis	Infection	*Pyelonephritis*
Osteoporosis	Osteomyelitis	Perinephric abscess
Fractures	Septic discitis	Aortic aneurysm
Congenital disease	Paraspinous abscess	Gastrointestinal disease
Severe kyphosis	Epidural abscess	Pancreatitis
Severe scoliosis	Bacterial endocarditis	Cholecystitis
?Type II transitional vertebra	Inflammatory arthritis (often HLA-B27 associated)	Penetrating ulcer
?*Spondylolysis*	Ankylosing spondylitis	Fat herniation of lumbar space
?Facet joint asymmetry	Psoriatic spondylitis	
	Reiter's syndrome	
	Inflammatory bowel disease	
	Scheuermann's disease (osteochondrosis)	
	Paget's disease	

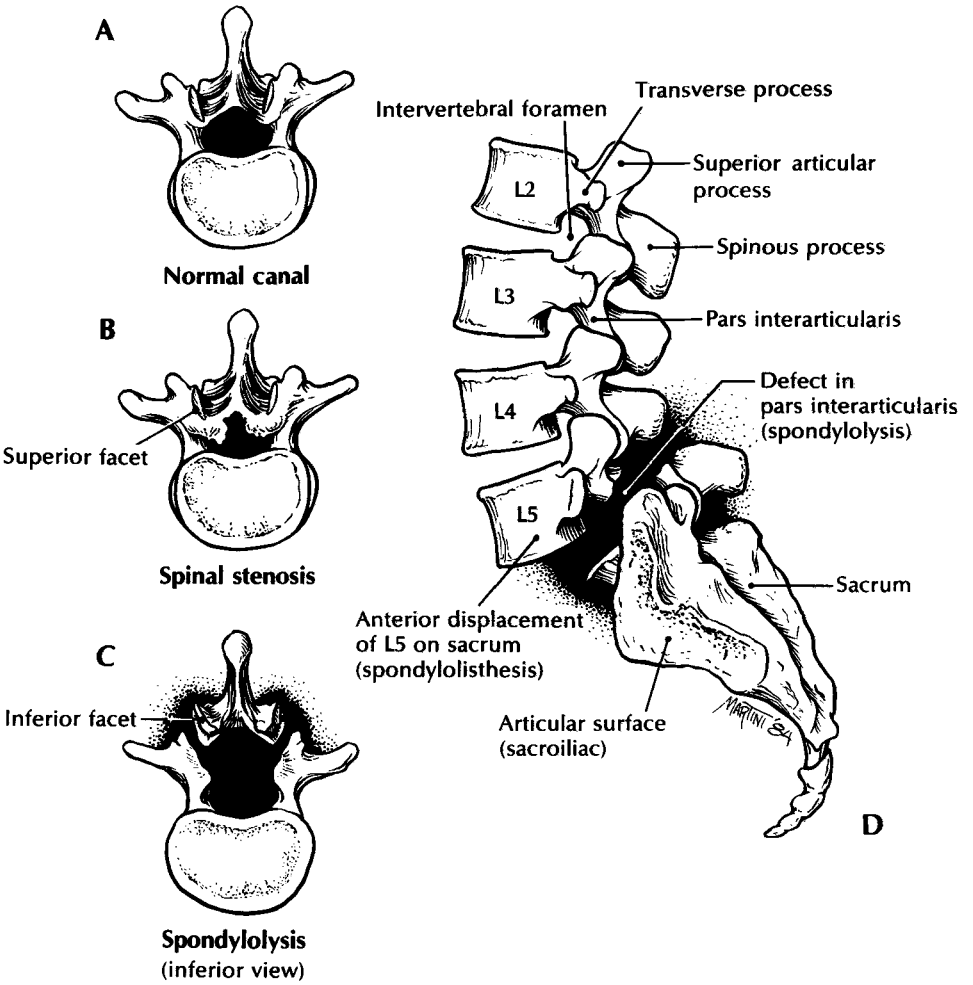

Figure 1. *A*, superior view of a lumbar vertebra showing normal anatomy and canal configuration. *B*, superior view of a lumbar vertebra showing hypertrophic degenerative changes of the facets, resulting in spinal stenosis. *C*, inferior view of a lumbar vertebra showing bilateral spondylolysis (defects in the pars interarticularis). *D*, lateral view of the lumbosacral spine illustrating spondylolysis of the L5 vertebra with resulting spondylolisthesis at L5–S1. Spondylolisthesis refers to the anterior displacement of a vertebra on the one beneath it.

Recognizing that this pathoanatomic uncertainty is the rule rather than the exception, expert panels have estimated that the cause of back pain is unknown in as many as 85% of cases.[4] Because disability related to back pain is so common but a specific underlying disease is so rare, this condition has been aptly described as an "illness in search of a disease."[5] While specific or serious diseases are rare, it is important to consider them, and to attempt to exclude those that require specific therapy.

The terms spondylosis, spondylolysis, and spondylolisthesis are a source of confusion. Spondylosis refers to degenerative disc narrowing and vertebral osteophyte formation. Figure 1 illustrates the difference between spondylolysis and spondylolisthesis. Spondylolysis is a defect in the pars interarticularis of the vertebra, which may be bilateral or unilateral. The defect may result from stress fracture, congenital anomaly, or other factors, and in most cases the etiology is obscure. Spondylolisthesis refers to the anterior displacement of a vertebra upon the one beneath it. This sometimes occurs in cases of bilateral spondylolysis, but also occurs simply as a result of degenerative disc disease. All degrees of displacement may be seen. They are graded from I (<25% of vertebral width) to IV (>75% of vertebral width). Spondylolisthesis most often occurs at the L5–S1 interspace.

There is growing interest in spinal stenosis as a cause of back pain, in part because this entity is clearly visualized by computed tomography (CT) of the spine. Spinal stenosis refers to narrowing of the central spinal canal or nerve canal. It may be congenital, or can occur as a result of a herniated disc, spondylolisthesis, operative procedures, or other factors.[6] Typically, however, the narrowing is the result of hypertrophic degenerative changes in the discs and facet joints which encroach upon the spinal canal, and especially the lateral recesses. Figure 1*B* illustrates this process. Our understanding of the clinical features and the radiologic criteria for this diagnosis are still evolving.

Interest in the facet joints as a locus of pain has also paralleled the use of CT scanning. Degenerative changes in these joints, which often develop simultaneously with disc changes at the same level, usually occur in late life. The role of the fac-

ets in the pathogenesis of back pain remains controversial. Large epidemiologic studies fail to show a relationship between radiographic degenerative changes of the facets and pain symptoms,[7] and the clinical evidence for an association is of uncertain validity.[8] Nonetheless, it seems reasonable to assume that these synovial joints, like others, could become inflamed and painful. Since degenerative change here often parallels that in discs, and may cause spinal stenosis, determining the precise cause of pain in an individual patient may be difficult, and multiple causes may be operative.

The relation of osteoporosis to back pain is also unclear. Certainly pain arises when compression fractures occur, but pain is often attributed to osteoporosis in the absence of radiologically evident fractures. Some have argued that microscopic fractures occur which are not clinically apparent.[9] Osteoporotic fractures of lumbar vertebrae and the sacrum may be spontaneous, with little or no trauma.

The non-mechanical causes of low back pain are familiar to most internists. An association between bacterial endocarditis and low back pain, however, may not be widely recognized.[10] Only a small portion of such patients prove to have metastatic disc space infections or osteomyelitis, most have normal spine radiographs, and the cause of the pain is usually unclear. Obviously, this diagnosis accounts for only a small fraction of patients with low back pain. Scheuermann's disease, another rare cause of back pain, is a derangement of endochondral ossification. It typically becomes apparent in preteen or early adolescent years and results in a slowly progressing kyphotic deformity. Although often symptomless, it is occasionally associated with dull aching pain.

Diseases of several subdiaphragmatic organs may cause back pain, including aortic aneurysm, endometriosis, prostatitis, and pancreatitis. The rare herniation of retroperitoneal fat in the lumbar space may manifest as back pain and the appearance of a tender lipoma.[11]

Prevalences of Disease Entities

Fortunately, serious infections, neoplasms, and inflammatory diseases are rare causes of low back pain. For example, using a primary care practice registry and published data, Liang and Komaroff estimated the likelihoods of infections or neoplasms among patients with acute low back pain.[12] These probabilities, shown in Table 2, are generally exceedingly small (one in 1,000 or less). The authors caution that probabilities might be substantially different in referral practices.

Support for the assertion that serious diseases are rare comes from several large series of consecutive lumbar spine x-rays, even though such series are undoubtedly selective. In many primary care settings only half of patients with back pain receive x-rays,[13] and those who do are presumably chosen for clinical reasons. This selection process tends to overestimate the prevalence of serious diseases. On the other hand, x-rays may fail to show specific abnormalities in some patients who prove to have infections or neoplasms, thus underestimating their prevalence. While we cannot quantify these biases, they probably counterbalance to some degree.

At least five large series of consecutive spine films have been analyzed, with sample sizes ranging from 200 to over 3,000.[14-19] Tumors, infections, and inflammatory spondyloarthropathies together were present in less than 2% of patients in every series. In many cases, patients with previously recognized malignancies were included. One study obtained six-month follow-up data for 621 walk-in patients with back pain, regardless of whether x-rays were performed. The prevalence of cancer as a cause was only 0.6%.[20] Thus, knowing only the chief complaint, we can estimate the likelihood of serious systemic illness to be small.

HISTORY AND PHYSICAL EXAMINATION

Since no specific pathogenetic mechanism is identified in as many as 85% of cases of back pain, attempts to make a specific diagnosis are likely to be disappointing. At the initial visit, it may be more useful to answer three basic questions: 1) Is there a systemic or visceral disease (requiring specific therapy) underlying the pain? 2) Is there evidence of neurologic compromise that may necessitate surgical intervention? and 3) Are there findings that influence the choice of conservative therapy? These questions can usually be answered on the basis of a history and physical examination alone. Recent studies have amplified the utility of the clinical evaluation by demonstrating reliability and validity (or lack thereof) for several of its components.

Is There Systemic or Visceral Disease?

The likelihood of serious illness is affected by the patient's age, and by whether or not there has been recent fever, weight loss, lymphadenopathy, history of tuberculosis, or cancer. The use of corticosteroids is associated with osteoporosis, compression fractures, and infection. Characteristics of the pain are important, since non-mechanical pain is usually continuous and is not aggravated by exercise, whereas mechanical pain is aggravated by motion and relieved by rest.

A history of urinary tract or abdominal symptoms suggests visceral disease. In older patients, the breasts and prostate should be examined (they are common sources of spinal metastases), and the abdominal aorta and femoral arteries should be examined for evidence of aneurysmal dilatation.

Calin and colleagues have devised a useful series of screening questions to aid in the detection of ankylosing spondylitis.[21] These questions are: 1) has discomfort been present for three months or more, 2) is there morning stiffness, 3) did pain begin before age 40, 4) was the onset insidious, and 5) is the discomfort alleviated by exercise? A positive response to four or more of these questions was found to be 95% sensitive and 85% specific for ankylosing spondylitis. Not surprisingly, however, when screening for a relatively rare disease such as ankylosing spondylitis, the predictive value of the test in an unselected population is low. Among industrial employees with back pain, 367 had a positive test by the "four or more" criterion. Only 16 proved to have ankylosing spondylitis, so in this setting the predictive value of the questions (the proportion of positive tests that were true positives) was only 0.04.[22]

On examination, spinal flexion may provide an additional clue to the presence of ankylosing spondylitis. Flexion should be assessed by the Schober test, which measures the distraction between two marks on the lumbar spine during forward flexion. This test is quite reproducible among observers,[23] although there is substantial overlap between patients with spondylitis, those with mechanical spine disorders, and healthy subjects. Nonetheless, a positive Schober test (criteria depend on age and gender[24]) suggests a loss of lumbar spinal flexion, and when accompanied by the suggestive historical features noted above, probably warrants radiographic evaluation of the spine.

Several tests for sacroiliac joint disease have been popularized as additional ways of detecting ankylosing spondylitis. Russell and colleagues, however, found these tests disappointing on critical scrutiny.[25] They found that none of six commonly described tests, including direct sacroiliac pressure, had any ability to discriminate between patients with ankylosing spondylitis and those with mechanical causes of low back pain.

Is There Neurologic Compromise Requiring Surgery?

Incontinence of urine or stool, difficulty walking, or bilateral lower extremity neurologic symptoms suggest the cauda equina syndrome. This syndrome results from massive cord or cauda equina compression from a midline disc herniation, tumor, or other mass, and is a surgical emergency. Physical signs of the cauda equina syndrome include loss of rectal sphincter tone, anesthesia in a "saddle" distribution, and bilateral leg weakness or reflex loss. These findings should prompt immediate surgical referral. This syndrome is probably the only reason for surgical referral at an initial visit. Fortunately, the cauda equina syndrome is present in only 2% of patients who undergo disc surgery.[26]

Indications for later surgical referral similarly depend almost entirely on the history and physical examination. While additional tests might be ordered for such patients to rule out systemic disease, they would not influence the referral decision. Indications for surgical intervention include the cauda equina syndrome and muscle weakness which is either progressive or fails to improve with conservative management.[27] Equivocal indications for surgery, requiring considerable judgment in their application, include reflex loss in the absence of weakness and persistent or recurrent disabling sciatica.

In the absence of these findings, surgical consultation is unnecessary. Furthermore, with the exception of the cauda equina syndrome, conservative therapy for four to six weeks is indicated prior to consideration of surgery in nearly all cases, since a majority of patients will improve without surgery. The surgical criteria are appropriate regardless of the underlying cause of mechanical pain, whether herniated disc, spondylolisthesis, or spinal stenosis.

The first clue to nerve root involvement is often a history of sciatica-like pain. Sciatica (radicular pain) typically radiates down the posterior or lateral aspect of the leg and is aggravated by coughing and sneezing. Although it is often equated with disc herniation, radicular pain may be associated with degenerative vertebral changes, spinal tumors, spondylolisthesis, various systemic causes of neuropathy, and even endometriosis. Furthermore, pain from facet joint disease and spinal stenosis may radiate to the legs. Features suggesting a herniated disc are relatively acute onset of pain, alleviation of pain while supine, and worsening of pain when upright. Leg pain may overshadow back pain, and the syndrome occurs most often in patients between the ages of 30 and 55.[26]

Over 90% of disc herniations occlur at the L4–5 or L5–S1 levels,[26] so the neurologic examination focuses on the L5 and S1 nerve roots. Almost 90% of patients with a surgically proven disc herniation have impairment of ankle reflexes or foot dorsiflexion.[26] Because herniation above L4–5 is rare, knee reflexes are impaired in only 5% of patients with proven herniations.[26] Sensory deficits corre-

sponding to L5 and S1 occur in the posterior and lateral aspects of the leg. While these help to confirm nerve root involvement, they are more subjective than motor deficits, and are probably not alone a valid indication for surgery.

Straight leg raising is a sensitive, but nonspecific, test for nerve root irritation. A positive result produces pain radiating down the back of the leg with thigh elevation of 60 degrees or less. This sign, like the Schober test, is quite reproducible among observers. A positive straight leg raising sign is present in about 95% of patients who prove to have a herniated disc at surgery. However, it is present in 89% of surgical patients with a negative exploration (no part of the disc protruding beyond normal anatomic limits) as well.[26]

Are There Findings That Influence the Choice of Conservative Therapy?

If there are no signs of systemic illness or major neurologic compromise, initial therapy is generally conservative and symptomatic. This is true regardless of radiologic anomalies or specific physical findings (many of which are unreliable[23]). Rather than seeking to identify a specific mechanical lesion, then, the primary clinician's time may be better spent eliciting features of the history and physical that influence therapy, regardless of pathoanatomic cause.

Initial management may be determined by the chronicity of symptoms, presence of neurologic deficits, presence of symptoms of depression, involvement in litigation or disability determinations, presence or absence of trauma, and prior back surgery. For example, narcotic analgesics may be inappropriate for treating chronic pain, but very helpful for the patient with severe acute pain. Patients with neurologic deficits may require longer and stricter bed rest than those without deficits.[28] Clinical depression or chronic pain may be an indication for the use of a tricyclic antidepressant. Litigation or trauma may influence the initial radiologic evaluation, as described in the next section.

Assessment of psychological and social factors surrounding the episode of back pain is often overlooked. Patients seeking compensation often respond poorly to a variety of treatments.[29] Stressful life events such as family crises and marital or employment problems may exacerbate the pain. Inquiries about functional limitation and general somatic or neurotic complaints may reveal unusual patterns of pain expression, excessive concern with health, or unrealistic expectations of treatment.[30]

Because back pain is often associated with psychological and social elements that offer secondary gains (monetary, behavioral, or emotional), several investigators have sought physical signs that would suggest either malingering or major psychogenic overlay. A careful assessment of such signs was recently performed by Waddell and colleagues, who discarded several because of poor reproducibility, observer bias, or overlap with better tests.[30] Five signs were found to be reproducible and statistically significantly associated with a variety of psychological abnormalities:

1. Tenderness unrelated to anatomic structures (e.g., tenderness to light pinch of skin over a wide area)
2. Tests to simulate spine loading or rotation without actually producing the simulated effect
3. Straight leg raising in the sitting position
4. Neurologic deficits without a physiologic or anatomic explanation (e.g., "cogwheel" release of muscle tone on strength testing, or "stocking" as opposed to dermatomal sensory deficits)
5. Overreaction during the examination, including disproportionate verbalization, facial expression, muscle tension or tremor, collapsing, and sweating

The presence of three of five of these signs suggested an important "nonorganic" component of pain. These signs should not be taken to support an artificial distinction between "psychogenic" and "organic" pain, since nearly all patients have elements of both. However, the presence of these "nonorganic" signs may identify patients who need more detailed psychological evaluation and perhaps those unlikely to respond to surgery.[30]

PLAIN LUMBOSACRAL SPINE RADIOGRAPHY

Indications for plain spinal radiography remain controversial. Some authors assert that lumbosacral spine films are an essential part of the routine spine examination. There is a growing consensus, however, that spine radiographs are not essential for every patient with back pain. Nonetheless, back pain is the symptom most often associated with x-ray use in ambulatory practice,[31] and some three million lumbar spine examinations are performed annually.

Those who advocate a selective approach note several drawbacks of routine radiography: high gonadal doses of radiation, the low yield of useful findings, the poor relationship of many abnormal findings to symptoms, and high costs. It has been estimated that lumbar spine radiography is the largest source of gonadal irradiation in the United States, and that a single lumbar spine series results in gonadal doses equivalent to a daily chest x-ray for over six years.[32] It is estimated that one million lumbar spine x-rays may result in 20 excess

deaths from leukemia. A million studies among prospective parents may result in 400 excess cases of genetic disease.[33] Inadvertent irradiation of pregnant women is an additional risk.

As noted previously, the yield of serious findings affecting initial therapy is low. Malignancies, infections, and inflammatory spondyloarthropathies together are found in less than 2% of studies. Spondylolisthesis and fractures are found in another 10–15% of studies, but it is unlikely that these findings usually affect therapy.[14-19] The largest study was a ten-year review of 68,000 lumbar spine radiographs performed in a Swedish hospital. Clinically unsuspected findings were detected in approximately one of every 2,500 examinations among patients aged 20–50 years.[34]

Plain radiography is not a sensitive screening test for many spinal infections or neoplasms. Based on literature reports and expert opinion, Liang and Komaroff estimated the likelihoods of abnormal x-ray findings at an initial visit for several types of infections and neoplasms. As shown in Table 2, these estimates ranged from 25% for disc space infections and spinal epidural abscesses to 66% for most neoplasms and 90% for pyogenic vertebral osteomyelitis.[12]

Many radiographic findings are not demonstrably related to back pain. Demonstrating cause and effect with regard to radiographic findings is difficult, and requires comparing the prevalences of a given abnormality in a symptomatic population and an asymptomatic population. This has been achieved using radiographs from pre-employment screening programs, military studies, and some population surveys.

For example, spondylolysis is often cited as a cause of pain, but appears to be as common in asymptomatic persons as in those with back pain.[35] This is a consistent finding in large surveys. Studies purporting to demonstrate a causal relationship have not distinguished between spondylolysis and spondylolisthesis. Spondylolisthesis is clearly more common among symptomatic than among asymptomatic persons, so a failure to distinguish the two conditions may obscure true relationships.

Similar controversy surrounds the etiologic roles of transitional vertebrae, apophyseal joint disease, and varying degrees of spondylosis. Nachemson has attempted to summarize existing data on several radiographic anomalies, and to classify them according to the probabilities of their association with pain symptoms.[34] In this classification (which has been adapted by others[32]), single disc narrowing, most radiographic changes in the apophyseal joints, disc calcification, many transitional vertebrae, spina bifida occulta, Schmorl's nodes, and mild–moderate scoliosis would be considered unlikely to cause pain. Spondylolisthesis, Scheuermann's disease, congenital kyphosis, osteoporosis, multiple narrowed discs, and ankylosing spondylitis are considered definite causes of pain. An "uncertain" category would include spondylolysis, retrolisthesis, severe lordosis, and severe lumbar scoliosis (>80°). Although several of the assignments in this scheme remain controversial, it is a useful working classification for clinicians and investigators as we await further data.

Because of the limitations and drawbacks of routine lumbar spine radiography, several authors have proposed selective use of x-rays based on clinical findings. Features of the history and physical examination may suggest the presence of infectious, neoplastic, or inflammatory disease, so the following criteria (or similar lists) have been proposed for early radiography:[20, 27, 36]

1. Age over 50
2. Fever
3. Findings suggestive of ankylosing spondylitis
4. History of previous malignancy or striking weight loss
5. Significant trauma
6. Motor neurologic deficits (including cauda equina syndrome)
7. Intended litigation or compensation
8. Use of corticosteroids
9. Drug or alcohol abuse

The study of unexpected findings in patients under age 50,[34] the data ultilized in a formal decision analysis[12] (Table 2), and a recent prospective study[20] suggest that in primary care there is a very low risk of overlooking serious disease if x-rays are limited to patients with these indications. All would advocate x-ray examination if symptoms are not alleviated in two to four weeks. Although these criteria are logical and have support in the literature, it is not clear whether their implementation would reduce current x-ray utilization.[20]

In addition to only selective use of x-rays, it may be possible to reduce the cost and radiation exposure associated with each examination. In many facilities a standard lumbosacral spine series consists of five views: anteroposterior, lateral, two oblique views, and a coned lateral view of the L5–S1 junction. The last view is included because it is the most common site of spondylolisthesis, and is occasionally not well visualized on the routine lateral view. Over the last five years, as shown in Table 3, investigators have questioned the need

TABLE 2

Clinical Characteristics of Serious Neoplastic and Infectious Causes of Back Pain

Feature	Spinal Epidural Abscess	Pyogenic Vertebral Osteomyelitis	Tuberculous Osteomyelitis	Disc Space Infection	Multiple Myeloma	Metastatic or Primary Bone Tumors
Estimated prevalence in primary care patients with acute low back pain*	0.000037	0.000037	?	0.000037	0.00007	0.0012
Age ≥50 years	40%	52%	54%†	47%	90%	73%†
Abnormal erythrocyte sedimentation rate						
≥50 mm/hr	?	87%	18%	67%	76%	44%
≥20 mm/hr	?	94%	71%	88%	90%	82%
Leukocytosis (≥12,000/mm³)	65%	42%‡	17%	4%	25%§	14%
Fever	83%	52%	27%	36%	1%	16%
Abnormal x-ray at initial visit*	23%	90%	?	25%	66%	68%
Other common features	Furuncles Vertebral osteomyelitis (35%) Prior trauma (25%)	IV drug abuse Recent surgery Urinary tract infection, recent catheters	Positive tuberculin skin test (77–100%) Pulmonary involvement (5–69%)	Recent disk surgery Other infections	Anemia (62%) Proteinuria (88%)	Weight loss Adenopathy, breast and prostate common primary sites
Neurologic deficits at time of diagnosis	89%	17%	50%	?	?	18%

* Estimates based on Liang et al.[12]
† Age ≥45 years in one series.
‡ >10,000 leukocytes/mm³.
§ <4,000 or >10,000 leukocytes/mm³.

for the oblique and coned lateral views, and have examined the diagnostic loss that would occur from excluding them.[14-18, 37, 38] Together, these studies included 2,397 consecutive lumbosacral spine examinations. In only one case was a diagnosis apparent only on the oblique views which clearly affected therapy. This was the case of a patient with an osteoid osteoma (a benign bone tumor) in the study of Gehweiler et al.[17] Other missed diagnoses consisted largely of spondylolysis and degenerative changes of the facet joints. As noted earlier, the association of these radiographic findings with symptoms remains uncertain. Furthermore, the initial therapeutic approach for such patients would be the same as that for lumbar strain in the absence of x-ray abnormalities. On the basis of this evidence, a World Health Organization report recently recommended that oblique projections not be routinely obtained, but be used only for special problems after review of anteroposterior and lateral views.[39]

Two studies have addressed the need for the coned lateral view. Eisenberg found that a well-centered lateral view showed the lumbosacral junction as well as the coned lateral view in 28 of 30 examinations.[37] Scavone found no diagnoses attributable to coned lateral views that were not apparent from routine anteroposterior and lateral views.[15] Based on the studies summarized in Table 3, a number of radiologists advocate limiting the standard lumbosacral spine examination to an anteroposterior view and a well-centered lateral view.[15, 32, 38] This strategy would eliminate two thirds of the gonadal radiation dose per examination, and by one estimate would save 45 million dollars per year on a national basis.[15] Use of oblique and coned lateral views might be limited to very exceptional circumstances with little if any loss of diagnostic accuracy or therapeutic benefit.

COMMONLY RECOMMENDED LABORATORY TESTS

Most authors recommend a variety of blood and urine tests for all patients complaining of back pain. These tests are not helpful in distinguishing among the causes of mechanical pain, and are useful only to screen for underlying neoplastic, inflammatory, or infectious processes. Both standard medical textbooks and widely read books for consumers suggest that a complete blood count (CBC), urinalysis, and erythrocyte sedimentation rate (ESR) are parts of the minimal evaluation. However, the yields of these tests and their sensitivities, specificities, and predictive values have never been critically examined. Because systemic causes of back pain are infrequent, and because none of these tests is specific for causes of back pain, the predictive value of a positive test is likely to be low (i.e., there are many false positives). These recommendations therefore deserve careful scrutiny.

Table 2 provides estimates of the likelihood of an abnormal white blood cell count (WBC) or ESR for each of several infections and neoplastic dis-

eases. These figures represent weighted averages from a number of case series. The WBC is infrequently abnormally high in any of these conditions, and thus is an insensitive screening test. Elevations of the ESR are much more common (71–94%), and the ESR might therefore be better for screening purposes. In fact, the ESR may be more sensitive than radiography in many of these conditions. Some authors have even suggested that the ESR should replace routine radiography during initial screening.[40] The low specificity of the ESR, however, suggests that even its application should be selective. The presence of clinical findings suggesting systemic disease (e.g., the items listed in Table 2 and the x-ray indications noted above) may improve the predictive value of an elevated ESR.

Urinalysis may suggest urinary tract infection, urolithiasis, and multiple myeloma. However, dipstick methods for urinary protein are insensitive to Bence Jones protein, and pyelonephritis or urolithiasis in the absence of clinical findings other than back pain is unusual. Thus, selective use of urinalyses is probably warranted, though adequate studies are lacking.

Various other tests have been advocated, including determinations of serum calcium, phosphate, and alkaline phosphatase, protein electrophoresis, and, for men, measurement of acid phosphatase. Some suggest even more extensive testing as part of the "minimum evaluation." Serum creatinine, uric acid, fasting blood sugar, SGOT, thyroid function tests, antinuclear antibodies, and rheumatoid factor have all been suggested as appropriate components of the initial evaluation. The variety of recommendations attest to the absence of adequate data on the yields or utilities of these tests for the patient whose chief complaint is back pain.

Because the yields, specificities, and predictive values of these tests are likely to be low, it seems reasonable to reserve them for patients who have abnormalities disclosed by the ESR, spine radiographs, or clinical examination. This position is well argued by Fries, who calls for restraint in the initial laboratory evaluation of patients with joint pain (including back pain). He points out that in addition to direct costs, false-positive laboratory results may lead to further tests, excessive concern, patient dependency, erroneous diagnostic labeling, or ill-advised therapy.[36]

Controversy still surrounds the clinical use of the HLA-B27 histocompatibility antigen, although the issues have recently been sharpened and better defined. Some argue for its use in selected situations,[41] but others maintain that there are few if any indications for its clinical use.[42] There is agreement, however, on some major points. First, it is not an appropriate screening test for ankylosing spondylitis or Reiter's syndrome. This is because the B27 antigen is present in about 6% of Caucasians, while ankylosing spondylitis occurs in less than 1%.[43] Thus, in an unselected population, the predictive value of a positive test is low, with less than 15% of positives being "true" positives. Because low back pain is nearly ubiquitous among adults, we may presume a low predictive value among all patients with low back pain as well. Second, radiographic abnormalities are the *sine qua non* of ankylosing spondylitis. In the presence of radiologic sacroiliitis and compatible clinical

TABLE 3

Studies of the Yields of Oblique and Coned Lateral Views of the Lumbosacral Spine

Study	Sample Size	Sampling Frame	Views Considered*	No. of Missed Findings	Missed Diagnoses
Rhea et al., 1980[14]	200 patients	Consecutive studies from emergency room patients	Obliques	4	3 spondylolysis 1 postoperative change
Eisenberg et al., 1980[18]	704 studies	Consecutive veterans examined for disability compensation	Obliques	5	1 spondylolysis 4 mild facet joint changes
Gehweiler et al., 1983[17]	500 studies	Consecutive inpatient and outpatient studies	Obliques	59	33 facet arthritis 22 spondylolysis 2 facet joint anomalies 1 elongated pars interarticularis 1 osteoid osteoma
Scavone et al., 1981[15]	782 patients (993 examinations)	Consecutive inpatient and outpatient studies	Obliques Coned lateral	19	18 spondylolysis 1 congenital anomaly (facet fusion)
Eisenberg et al., 1979[37]	30 patients	Not stated	Coned lateral		Diagnoses not listed; well-centered lateral showed lumbosacral junction as well as coned lateral in 28/30 examinations

* Each examination was read with and without the views listed to determine what diagnoses might be missed.

findings the diagnosis is established, making HLA-B27 typing superfluous. Third, the antigen is found in 90% of whites with ankylosing spondylitis, but only 60% of blacks.[43] Thus, the predictive value of a negative test is low in blacks, and a B27 test cannot be taken to prove or disprove the diagnosis in whites.

The controversy, then, centers only on the patient with equivocal x-ray changes who appears clinically to have a reasonable probability of having ankylosing spondylitis (a probability which is close to neither 0% nor 100%). Khan and Khan argue that the test improves the certainty of diagnosis in this situation.[41] Calin, however, notes that the B27 test will not prove the diagnosis, and a trial of appropriate exercises and medication for such a patient would be warranted whatever the result. A later radiograph to confirm the diagnosis would be necessary in any case.[42] Whichever point of view one accepts, the clinical indications for use of this test are rare, and physicians must interpret results with a sound knowledge of its epidemiology and predictive value.

NEWER IMAGING PROCEDURES

Computerized Tomography (CT)

Use of CT scanning for the diagnosis of herniated lumbar discs was demonstrated in 1979, and its popularity has grown rapidly. In sensitivity (around 95%) and specificity (68–88%) it is roughly equal to myelography in the diagnosis of herniated discs,[44, 45] and in some centers CT scanning has largely replaced myelography.[46] The occasional adverse effects of myelography are thereby avoided, and charges for CT scanning ($350–600) are generally less than those for myelograms, which require hospitalization and total charges of around $2,000.

The use of CT scanning has also contributed to our understanding of spinal stenosis. This lesion is sometimes not apparent on myelography, and CT scanning has become important in its diagnosis.[46] Although computerized tomography is not appropriate as a routine procedure, it is indicated when clinical findings suggest spinal stenosis and there are associated neurologic deficits or disabling symptoms (pain and postural changes). Arthritic changes of the facet joints (often related to spinal stenosis) are also particularly well visualized by CT. Until more specific therapy is available, however, scanning to demonstrate facet joint disease in the absence of neurologic deficits is probably unnecessary.

Computerized tomography has also been used to detect sacroiliitis. The technique is more sensitive (81%) than plain x-ray among HLA-B27-positive patients with clinical findings of sacroiliitis, but may be somewhat less specific (70%). Further experience with interpretation of these images is necessary before their place in clinical decision-making is clear.

Experience with CT among patients with osteomyelitis or paravertebral infections is limited, but bony and soft-tissue abnormalities are well delineated. It is quite possible that with more experience CT will replace conventional tomography and myelography in the evaluation of these patients. Recent studies have also demonstrated that quantitative CT of the vertebrae is a sensitive method for measuring bone loss in surgically menopausal women. Its role in routine clinical management of osteoporosis, however, is not yet defined.

In general, CT is reserved for evaluation of patients for whom surgery is contemplated. Definitive diagnosis of a herniated disc or spinal stenosis becomes important primarily if neurologic deficits are present and persist in the face of conservative therapy. When the clinical neurologic findings correspond to the radiographic findings, a causal association is likely.

Radionuclide Scanning

Bone scanning is extremely sensitive in detecting malignant and infectious lesions, where it is positive earlier than plain radiography. In one series of cancer patients who were studied with both plain x-ray and bone scanning, false-negative scans occurred in only 0.4% of patients.[47] The specificity of radionuclide scanning is poor, however, especially when solitary abnormalities are found. Among 172 patients with known metastatic cancer and a solitary lesion on scan, 36% had benign lesions that caused the bone scan abnormality (e.g., degenerative arthritis, Paget's disease).[48] Some advocate radionuclide scanning for any elderly patient who fails to respond to conservative care in four to six weeks, or who has severe low back pain that is worse at night. Others have pointed out that among patients with metastatic or infectious lesions and positive bone scans, the ESR is virtually always elevated. These authors conclude that bone scanning is not useful for the patient with chronic low back pain who has a normal radiograph and ESR.[49] Given the large number of false positives, it seems reasonable to limit the use of bone scans to patients with high probabilities of infection or cancer (e.g., those with weight loss, elevated ESR, fever, or suggestive physical findings).

The use of radionuclide techniques for the diagnosis of sacroiliitis has recently been investi-

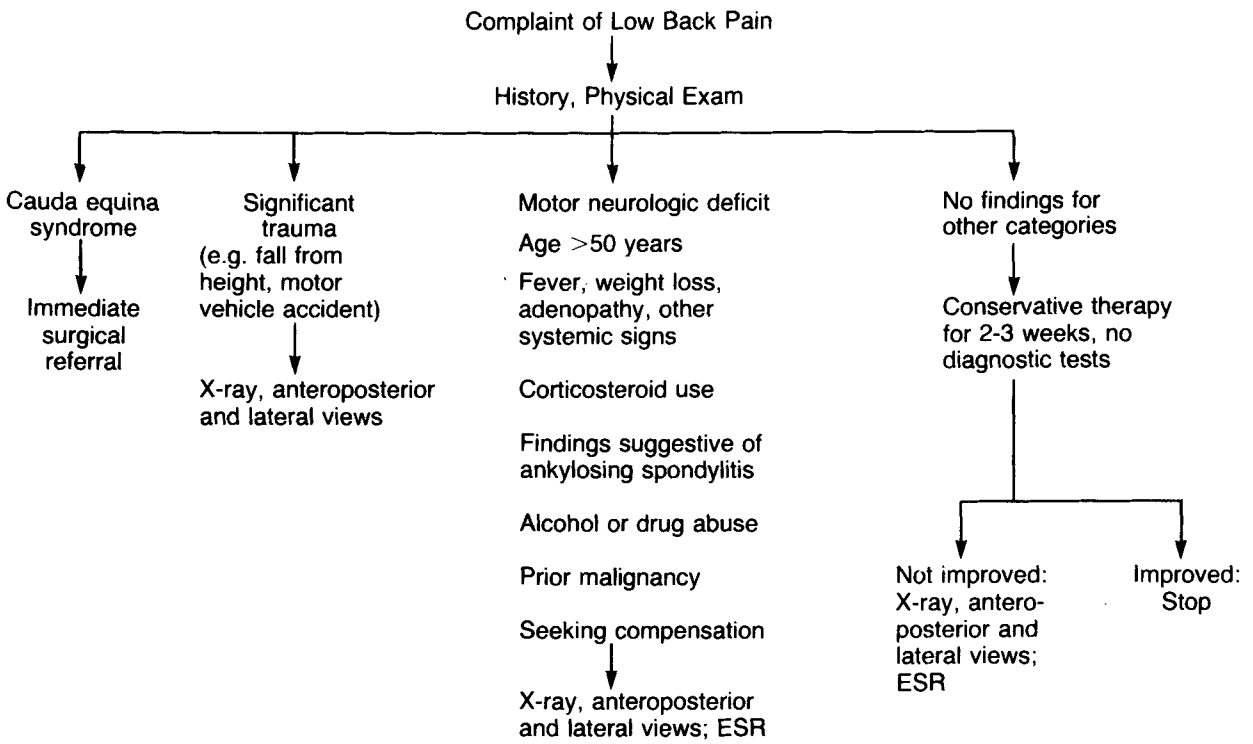

Figure 2. A proposed algorithm for the initial approach to a patient with low back pain. Subsequent diagnostic testing is highly individualized, depending on results of the tests shown here, clinical findings, and response to initial therapy. ESR = erythrocyte sedimentation rate.

gated. While it was hoped that quantitative scintigraphy (comparing sacroiliac joint uptake with uptake over the sacrum or femur) might increase specificity, most studies have found abnormal results in patients with a variety of noninflammatory conditions, and false negatives have been common. At present the test appears to be too nonspecific for other than investigational use.

Myelography

This procedure was the standard for the preoperative diagnosis of a herniated disc prior to the availability of CT scanning. Its sensitivity for disc herniation is about 92%, and reported specificity is 64–87%[44, 45] It is also useful in the diagnosis of spinal stenosis and other lesions of the spinal canal. Water-soluble contrast media such as metrizamide were introduced for myelography in the mid-1970s, and have largely replaced iophendylate (Pantopaque). Unlike iophendylate, the water-soluble media do not require contrast retrieval at the end of the procedure, provide good visualization of the actual nerve roots, and have fewer side effects.

In some centers, CT has largely replaced myelography, but it remains to be seen how complete this substitution will be.[50] Like CT scanning, myelography is generally indicated only when the patient is a potential surgical candidate.

AN INITIAL DIAGNOSTIC APPROACH

An initial diagnostic approach to the patient with low back pain, based on this review, is suggested in Figure 2. It uses diagnostic procedures sparingly, but would pose very little risk of overlooking serious disease. Subsequent diagnostic evaluation would be highly individualized, depending on results of the evaluations shown and response to initial therapy. This algorithm would result in substantial savings over a strategy of performing x-rays, CBC, ESR, and urinalysis for all patients with low back pain, as some advocate. Whether it would result in savings over actual current practice remains to be seen. As more and better data become available, we may anticipate modifications in this scheme. Furthermore, like all algorithms, this approach is not meant to supplant clinical judgment. Exceptions will be necessary in some cases, and certain patients will not fit neatly into the scheme.

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A complete reference list is available on request.

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