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Diagnosis and treatment of back pain.

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After completing this article, the reader should be able to:

* Describe the anatomy of the spine and explain why precise diagnosis of back pain is difficult.

* Summarize some of the ways in which psychosocial factors might influence back pain.

* Discuss which imaging studies are used to assist in diagnosis and what drawbacks exist to imaging in the absence of red flags.

* Address special considerations in imaging back pain patients.

* Explain different treatment options, including complementary treatments.

Back pain in its varied presentations is notoriously difficult to diagnose, and descriptions of diagnostic errors unfortunately abound. Imaging plays an increasing role in helping physicians pinpoint the cause of back pain, determine what treatments might be most appropriate and gain a better understanding of the processes underlying this all-too-common phenomenon.

About 10% of adults suffer from chronic pain, and back pain is the leading cause of chronic pain. Chronic pain predictably reduces the quality of life, increases anxiety and depression and now is associated with cognitive and morphological brain abnormalities. (1) Some researchers claim that the proportion of patients whose chronic low back pain (LBP) cannot be diagnosed properly would be reduced by as much as 50% if the potential of modern diagnostic techniques (ie, imaging) were recognized. (2) Imaging also is used to explore brain activity associated with pain, assisting scientists in obtaining a new understanding of the physiological changes associated with pain.

Still, obtaining an accurate diagnosis can be a long process. In 1 instance, a 71-year-old woman was referred to neurosurgeons following a history of LBP that had lasted for more than 10 years. (3) At first, as is typical practice, the woman's general practitioner attributed the back pain to a mechanical cause and recommended conservative treatment that resulted in some level of improvement. After 5 years, however, the pain worsened, and several other diagnoses were proposed, including arthritis, muscle strain and even psychosomatic pain. A full 10 years into the saga, the patient began to experience radiating pain near her knee, numbness and a decreased knee jerk. A neurological examination was otherwise normal, and lumbar-spine radiography showed only expected arthritic changes. Finally, magnetic resonance (MR) imaging permitted physicians to see a mass attached to a nerve root in the lumbar spine. Once the mass was removed, the patient experienced complete relief of her long-term symptoms. It had taken more than 10 years to achieve an accurate diagnosis and obtain true relief of her pain.

Sometimes, pain does not prompt diagnosis and treatment. In another case, a 29-year-old man who had no pain simply went for a Chinese massage, during which a mass was palpated in his right lower abdomen. Although he did not demonstrate any neurological impairment, an MR scan showed a large mass ventral to the spinal column (see Figure 1). The benign tumor was removed surgically without any adverse consequences. (4)

How Common Is Back Pain?

The only neurological complaint more common than back pain is headache. (5) Back problems are recurrent--rarely do they go away and stay away. (6) Between 5% and 10% of patients will develop chronic back pain. (7) Back pain generally is characterized as LBP or other, less common forms of back pain. With respect to acute LBP, the annual consultation rate is at least 35 per 1000 adults. (8) Americans spend more than $50 billion each year on LBP, which is the most common cause of job-related disability and a major contributor to missed work. (5) The American Academy of Orthopaedic Surgeons reported that back pain leads to nearly 12 million visits to physicians' offices each year and that 80% of the

population will at some time experience some form of back pain. (9) Other estimates place the figure even higher, predicting that up to 95% of Americans will experience back pain during the course of their lifetimes. (10) Approximately 15% of all adults have recurring LBP, and at least 5% become disabled due to LBE. (11) In 1998, total expenditures associated with back pain in the United States were reported to be more than $90 billion. (12) In 2003, the most recent year data are available, that figure was reported to be a full $10 billion higher. (13)

Americans have not cornered the market on back pain. In the United Kingdom, direct costs associated with disability due to LBP in 1998 were estimated at around 1.6 billion [pounds sterling] per year, with approximately 120 million work days lost. (14) At least once a year, a full 7% of the UK adult population consults a physician regarding LBP. (15) Researchers claim that more than 70% of people in developed countries will experience LBP at some point. (7) In the Netherlands, the costs to society of LBP have been estimated to be 1.7% of the gross national product, with 64% of those costs attributed to absenteeism from work. (16)

Much of back pain can be attributed to lifestyle choices: obesity, sedentary work and home environments and lack of consistent exercise. For some, including health care workers, back pain may be an occupational risk. Given the inherent costs to society, some argue that back pain should be demedicalized and in the absence of clear pathology and red flags indicating probable complications patients should be referred for physical therapy and prescribed exercise programs. (8) That argument might be bolstered by the results of some studies that have shown that about 90% of patients with LBP will have stopped conulting their primary care physician within 3 months. (17)

[FIGURE 1 OMITTED]

Early and accurate diagnosis of back pain and targeting appropriate treatment will reduce patient suffering and the medical and work-related costs of back pain. Diagnostic accuracy is essential for effective treatment. With respect to disk pain, pain patterns provide minimal diagnostic information, and the practice of diagnosing back pain based solely on patients' pain maps or drawings has been shown to have little real success. (2) Rarely can physical examinations distinguish between pain caused by a disk problem and some other cause. In children and adolescents, it is essential to rule out an organic etiology as a cause of back pain. (18) Thus, imaging has an important role to play in refining diagnoses and choosing a treatment. This article focuses on when and how imaging can contribute to a better solution to the problem of back pain.

Anatomy of the Back

Back pain is difficult to diagnose, largely due to the back's complex anatomical structure. It is composed of bone, muscle, ligaments, tendons and a network of neurological components. (19) The spine, or spinal column, which is made up of more than 30 vertebrae, supports the weight of the upper body and surrounds and protects the spinal cord. (5) More than 50 nerve roots enter and exit the spinal cord through spaces between the vertebrae; the intervertebral spaces are maintained by circular, spongy pads of cartilage known as intervertebral disks. (5) These cushioning disks allow flexibility in the lower back and act as a form of shock absorber. Facet joints are the places on each vertebra where the bone articulates with another vertebra, rib or both. (10,20) In the lower back, facet joints carry from 10% to 15% of the compressive load. (10) Ligaments and tendons hold the vertebrae in place and attach muscles to the spinal column.

[FIGURE 2 OMITTED]

The vertebrae are divided into 4 sections: There are 7 cervical (neck) vertebrae (C1-7), 12 thoracic (upper back) vertebrae (Tl-12), 5 lumbar (lower back) vertebrae (L1-5), and a group of bones fused together at the base of the spine known as the sacrum and coccyx (see Figure 2). (5) When the anatomical structure of the spine is altered so that the various parts cannot interact properly, dysfunction results and pain can occur. Predictably, most back pain is found in the lumbar area, which is responsible for supporting the majority of the upper body's weight. This is also the area of the spine that exhibits the most movement. Lumbar spinal motion is quite varied: The healthy lumbar spine flexes, extends, bends laterally and rotates on its axis. (10)

The lumbar disks are composed of:

* An outer rim or annulus fibrosus, which is made up of fibrous tissue.

* The core or nucleus pulposus. A healthy core is approximately 70% water.

* The top and bottom of the disk, also known as the cartilaginous end plates, which are the portions that rest against the neighboring vertebrae. (21)

Disks are the largest structures without a vascular system in the body. Blood vessels lie on the surface only, and so they obtain nutrition from diffusion through the end plates. In addition, disks are only minimally innervated; nerve endings are found only on the surface of the disk. (21)

Disks are designed with crisscrossing fibers that permit them to withstand twisting and other dynamic loads, but they still can tear and cause "discogenic" pain. Lumbar disk herniations are one of the most common diagnoses, and there is significant controversy concerning what treatment is most appropriate for herniated disks. When a disk becomes herniated, either the core or the outer rim of the disk protrudes through its confining membrane. (20) Sometimes these bulges impinge on nerve roots, resulting in pain. Often, however, they are asymptomatic. (21)

The Varied Faces of Pain

Dorland's Medical Dictionary defines pain as "a more or less localized sensation of discomfort, distress, or agony, resulting from the stimulation of specialized nerve endings. It serves as a protective mechanism insofar as it induces the sufferer to remove or withdraw from the source." (20)

Pain teaches us not to touch a hot stove, tells us when we should stop running and sends us to the doctor's office for explanation and relief. Learning from painful experiences also can enhance chances of survival. Pain control--largely approached in Western medicine through the use of pharmaceuticals--has become an area of medical specialty, yet consistent relief of this "symptom" is often elusive:

In the 21st century, it is ironic that although we have made

significant advances in our understanding of how pain affects the nervous system and continue to develop innovative treatments, many pain sufferers, including dying cancer patients, receive little or no treatment. One possible explanation is the dizzying development of scientific theories of pain physiology, including the different subtypes of pain and the associated improvements in available treatment options, counterbalanced by increasing regulatory scrutiny and limited financial resources for some patients. (22)

Further complicating the picture, studies show that people experience pain differently; there are varying responses to pain in different ethnic groups and, in turn, varying responses to treatment. (23) Pain responses to stimuli understandably differ. The annoying paper cut results in a dramatically different pain response than does, for example, a broken leg, cancer or pain experienced by heart attack victims. Moreover, pain is impossible to measure objectively: Patients with the same diagnosis and profile might rate their pain on a scale of 1 to 10 and come up with very different numbers. Although the intricate, complicated knot of factors that determines how pain is experienced and reported can render the accurate diagnosis of back pain extremely problematic, imaging is making significant contributions to the understanding of pain and pain behavior.

Traditionally, back pain has been viewed as resulting from some mechanical cause: compression of a nerve or some form of nerve dysfunction. (24) Back pain generally begins after injury or trauma, but it also can be due to degenerative conditions such as arthritis, bone disease, viral infections, irritation to joints or disks and congenital abnormalities. Factors that can contribute to LBP include obesity, smoking, stress, poor physical condition, pregnancy weight gain and poor posture during waking or sleeping hours. (5) Fatigue can increase pain. (25)

Newer approaches to studying the genesis of back pain view the problem on a more minute level, including analysis of immunobiologic and cellular mechanisms. (24) Scientists are continuing to refine their understanding of the underlying cause of back pain as a form of inflammatory process, and studies now focus not only on the vascularization of tissue but also on the types of inflammatory cells found in involved tissue. (24)

Pain can be acute or chronic. Acute pain, such as that suffered by people with appendicitis, serves a clear function: It alerts, warns and provides good indicators as to causation. (22) Acute pain is of short duration and usually subsides once the injury is healed or the problem is resolved. (7) Acute back pain can result from lumbar strain or sprain or from a fracture such as an osteoporotic fracture. (26) Chronic pain, generally defined as pain that lasts longer than 12 weeks, does not serve the same sort of "useful" purpose. Pain that recurs frequently or that lasts beyond the normal healing period also is categorized as chronic pain. (7) Examples of subacute or chronic back conditions include degenerative disk and joint disease, malignancy, fibromyalgia and Parkinson disease. (26) A fundamental step in making an accurate diagnosis is determining whether pain is chronic or acute.

The longer chronic LBP persists, the less the chance of avoiding disability. (17) Many factors appear to determine whether acute back pain will evolve into chronic pain. Some of the factors that contribute to chronic pain include age, physical fitness level, smoking, obesity, low educational level, stress, anxiety, negative moods or emotions, attitudes and beliefs and job dissatisfaction. (16,17) Functional MR (fMR) studies of brain activity connected with chronic pain demonstrate that chronic back pain, no matter what the initial causation, presents a well-defined set of abnormalities. (1) Disconcerting results of fMR studies also reveal a specific pattern of brain chemical changes consistent with decreased gray matter density, which is associated with decreased ability in emotional decision making. (1)

Even more minute changes in brain functioning have been discovered in the brains of people suffering from chronic LBP. Diffusion tensor imaging, which tracks the transport of water molecules in brain tissue, has identified significant alterations in the microstructure of the brain processing centers in these patients. These findings confirm that some effects of chronic pain are a reduction in the plasticity of the brain and flooding of the brain's pain centers with signals. (27)

Magnetic resonance spectroscopy (MRS) can detect biochemical changes, such as pain, that are associated with brain abnormalities. (28) In 1 study, researchers using MRS to analyze biochemical changes in 3 areas of the brain were able to distinguish subjects suffering from LBP from a control group with accuracies of 97% to 100%. (28) Scientists hope that such studies will, in the future, permit development of "brain biochemical fingerprints" of different pain states and that such fingerprints will help physicians choose the most appropriate and effective treatment.

Back pain can be divided into 3 categories: systemic, nonsystemic or osteoporotic (see Table 1). (29) Systemic causes of back pain include tumors, infection and referred pain from causes such as abdominal aortic aneurysms. Systemic back pain demands immediate attention. Table 1 Types of Back Pain (29) Systemic * Pain patterns are distinctive. * Includes tumors, infections of the vertebrae or intervertebral spaces. * May be due to visceral problems such as intra-abdominal infections aortic or aneurysms. * Pain is usually nonpositional. * Likelihood of cancer increases with patients aged 50 years or older and in patients whose pain has lasted longer than 1 month. * This type of pain qualifies as a red flag and physicians are more likely to order imaging studies early in the course of diagnosis. Nonsystemic * This category of pain is further subdivided into neurogenic and mechanical pain. * Causes of neurogenic pain include spinal stenosis (narrowing of the central or lateral aspect of the lumbar spine, usually with age; ie, arthritis); and sciatica (pain associated with the distribution of the sciatic nerve, usually felt from the buttock down to the foot or in isolated regions of the leg). * Mechanical pain results from a motion or activity that stresses the soft tissues that support the spine (eg, muscles, ligaments, capsules of the facet joints) or that results in disk herniation. The onset of pain is abrupt. In elderly patients, lumbar degenerative disk disease can produce an unstable spine with episodes of acute pain following movement. Osteoporotic * Includes acute vertebral fractures and compression fractures, with pain lasting from 2weeks to 2 months. * Onset of pain is abrupt and intense, may be worse when standing and walking and relieved by lying down.

What Factors Affect How Pain Is Experienced?

Pain has been described as a symphony, in that it is a complex dynamic influenced by pain sensors (physiological), hormones (chemical), emotions and memory. Current research indicates that men and women might use different circuitry to modulate pain. Pain reactions are also highly individualized. In an experiment in which participants' jaw muscles were injected with salt water to simulate temporo-mandibular joint pain, positron emission tomography (PET) brain scans confirmed the differences in participants' pain responses. (13)

Many current studies of the pain process focus on the mind-body connection, looking in particular at the impact emotions have on how pain is experienced and on whether it develops into chronic pain. Studies have consistently demonstrated that the way in which patients handle their emotions (primarily stress) can affect their physical health. In particular, anger and innate hostility have been shown to correlate with health status, regardless of whether they are expressed or suppressed.

Anger-in personalities (those who tend to suppress anger) appear to experience more chronic pain and have been characterized as pain-prone patients. The more patients report hostility and anger suppression, the more poorly they adjust to chronic pain and the less likely they are to respond well to pain treatment.

Anger-out patients (those who express their anger rather than holding it in) also are reported to adjust poorly to chronic pain. Researchers theorize that these mental states--the reduced ability to manage anger or to resist the impulse to express anger--lead to frequent and intense or low level, sustained muscular contractions. These muscle contractions increase pain by reducing blood and oxygen flow to tissue. Scientists theorize that particularly vulnerable people are those who suppress anger that arises from a cynically hostile outlook (resentment, perceived slights, long-standing grudges).30 Some even go so far as to postulate that psychological factors are a better predictor of outcome than are physical factors. (3l)

Fear also can play a significant role not only in how pain is experienced but also in whether pain is experienced. The results of 1 study led scientists to conclude that pain-related fear nearly doubled the risk for a new episode of LBP. (6) Hypervigilance with respect to pain signals, or a heightened focus on pain, can diminish a person's ability to disengage his or her attention from the pain, resulting in a longer pain experience. Other psychological and sociological factors that affect pain experiences and perceptions include memories of past pain experiences, upbringing, attitude, expectations, beliefs, values, age and sex. (25)

People also are capable of marshaling these same factors to diminish the pain. Many athletes condition themselves to endure pain that would fell others. Some practitioners of Eastern disciplines walk on hot coals or control the usual physiological response to extreme cold. Even individuals who have been raised in stoic homes might experience less pain than those who have been rewarded with attention for expressions of pain.

MR is being used to explore these differing pain experiences. In 1 experiment, participants were exposed to the same painful stimuli (a heat simulator that raised a small patch of skin to 120[degrees]F) but had markedly different reports of pain." (32) For those who reported higher levels of pain, MR images showed increased activation in areas of the brain important to pain (ie, areas responsible for identifying the location of a pain source and processing the intensity of pain signals). Researchers theorize that incoming pain signals are likely processed by the spinal cord in a similar way, but cognitive centers color how the stimulus is experienced once the brain becomes involved. Pain expectations, past pain experiences and emotional states become involved, altering the way pain actually is felt.

The quality of sleep is yet 1 more factor integrally connected with how pain is experienced. Sleep difficulties actually might cause increased pain, although they also can be a result of pain or other psychosocial factors. Painful conditions prevent or disrupt sleep, and mood is affected by a lack of sleep. (33) Insomnia can result in reduced energy and diminished cognitive functioning, both of which affect how pain is experienced. Whether a patient will experience future back pain is unquestionably related to initial complaints of sleep difficulty-the greater the sleep problem, the more likely a patient is to experience future chronic pain, functional limitations and disability. (34)

Studies have demonstrated that patients with chronic LBP actually display an arousal disturbance in their brain waves during sleep, which results in a lack of restorative sleep. (33) Light, restless sleep patterns often are seen in patients with spinal arthritis. The lack of deep, restorative sleep produces fatigue, and fatigue can exacerbate the pain. Because the elements involved in LBP are complicated and interconnected, many physicians begin by treating the insomnia and depression that often accompany it. (26)

Back Pain in Adults

As people age, they inevitably experience more aches and pains, particularly when performing chores, jobs and other daily activities. About 15% of adults have recurring LBP, and at least 5% become permanently disabled. (11) The highest prevalence of LBP is in adults aged 45 to 64 years. (21) In addition to simple aging, behaviors engaged in over time (sedentary lifestyle, frequent driving, chronic cough, pregnancy, smoking and frequent lifting of heavy objects) eventually take a toll on the health of the spine. (21) Sometimes, back pain arises when a sedentary person becomes suddenly--and perhaps too enthusiastically--active. (5) Not surprisingly, the risk for disk disease and spinal degeneration increases with age.

Back pain appears in men and women equally, although women older than 45 years have more LBP than younger women. (5,35) Both gender and hormones play a role in how pain is experienced and which treatments might be most effective. Women tend to report more severe and long-lasting pain than do men, and a certain class of opiate painkillers appears to be more effective in women than men. (13) Psychosocial factors outside of the work environment have a decided effect on the development of LBP, although studies to date indicate that no difference between the sexes exists in terms of the impact of these factors. (35)

Physiological differences between the genders also might affect the ease with which certain treatments are achieved and the degree of success of those treatments. For example, in the case of lumbar discectomy, a procedure in which a mechanical probe is used to suction and cut bulging intervertebral disks, practitioners report that probes may be placed more correctly in women than in men due to women's flatter and wider iliac crests. (36) Up to 76% of pregnant women experience back pain during pregnancy, and 21% report continued pain as long as 2 years after delivery. (37)

The Athlete vs the Couch Potato

LBP is more common in men who are overweight or obese. (35) In a study that set out to determine whether different patterns of lumbar disk degeneration were related to different types of physical work (sedentary, static work vs dynamic occupations), healthy controls from both types of work groups all had smaller body mass indices (BMI, an accepted measure of body fat as a ratio of weight) than did study participants who complained of LBE (38) There are clear associations between body weight and lumbar disk degeneration. (38)

Athletes generally are considered to be well conditioned, have greater flexibility and have higher pain thresholds than the average adult. (10) These characteristics, in addition to a reluctance to permit limitations on their activities, might provide a sort of protection against back pain. Approximately 30% of the athlete population reports back pain--a lower rate than is seen in the adult population at large.

Athletic endeavors place great demands on the body and particularly on the lumbar spine. Many sports involve repetitive, high-impact movements (referred to as repetitive microtrauma and overuse phenomenon). (10) Some back problems seen in the general population are more prevalent in certain athletes and can cause greater limitation, in that the disease process can put a halt to an athletic career or pastime. For example, spondylolysis, which is a general term for defects or degenerative changes of a vertebra, is prevalent in the adult population, often asymptomatic and only incidentally detected on plain radiographs. (39) Spondylolysis also is considered to be an overload fracture. (40) In the young adult athlete population, it is the most common cause of persistent LBP and often is referred to as active spondylolysis.

Active spondylolysis is associated with nearly every sport, but activities such as gymnastics and diving put athletes at greater risk because those sports involve repetitive lumbar extension and rotation. (39) Other associated sports include swimming (butterfly stroke only), tennis, the high jump, weightlifting, ski jumping and tae kwon do. (40) MR has revealed that the prevalence of lumbar spine abnormalities is much greater in gymnasts than in swimmers, who did not engage in repetitive spinal loading. (10)

Trauma-induced Back Pain

The vertebrae, like other bones, are susceptible to fractures. Major trauma, such as a high-speed motor vehicle accident, is a risk factor for fracture, as is minor trauma in patients who are at risk for osteoporosis. (41) Minor trauma can include falls, sports injuries and lifting injuries. Short-lived back pain associated with minor trauma is very common. In a 5-year study by Carragee et al of the impact of minor trauma on the back, lifting-related injuries were the most common form of minor trauma associated with LBP. (42) The majority of LBP occurred when weights lifted were more than 60 pounds, and most of the lifting events that resulted in back pain involved lifting done in an awkward position.

The difficulty physicians face with patients who complain of back pain following major or minor trauma is when to order imaging and when to suggest conservative treatment. Many individuals involved in low-speed, minor automotive accidents will complain of muscular pain such as a wrenched back. For these patients, conservative treatment might suffice. Physicians must assess the mechanism of injury on a case-by-case basis, looking for red flags such as advanced age or pain that is not resolved with rest. (41) The physician's task is further complicated by a spate of studies that provide varying results.

Occupational Back Pain

The Third European Survey on Working Conditions found that 33% of European workers report back pain, making it one of the most common work-related health problems. (35) In the Netherlands, approximately 93% of back-related costs are due to absenteeism from work, and the majority of those costs are due to workers who are absent for more than 6 months. (43) In the United States, back injuries reportedly occur in about 2% of the work force each year, and yearly workers' compensation costs are estimated to be more than $20 billion. (7) The average workers' compensation claim, with the worker receiving only conservative care, ranges from $15 000 to $25 000; surgical interventions add a minimum of $15 000 to the cost of each claim. (11) These figures are expected to climb, particularly as the American work force ages. Aging workers have an increased chance of being injured and of suffering more severe injuries.

As discussed above, the majority of work-related back injuries occur when lifting heavier weights and when lifting in an awkward position. (42) The association between LBP and heavy labor, including the start of conditioning training in military recruits, is well documented. (42) In addition to heavy lifting, repetitive motion and vibration (for example, driving heavy machinery) are responsible for work-related back disorders. (35) Whether pain and disability follow similar patterns is a matter of disagreement among current research studies. (44)

One study that used MR to examine military veterans concluded that depression was an important predictor of new LBP, and numerous other studies point to psychosocial factors, including psychological aspects of work, as the best predictors of whether LBP will result in work incapacity and workers' compensation claims. (42) Other studies question the belief that LBP is a form of masked depression. In a study of Norwegian workers, emotional distress was found to be a predictor for work disability due to LBP, but only in people who had experienced earlier incidents of LBP. (45)

Many workers have credible back pain, but their degree of disability can be much higher than what would normally result from the back condition. Several studies have connected excessive claims of disability to psychosocial factors such as dislike of a particular supervisor and expected financial gain (through disability or personal injury claims). (42,46) Other work-related psychosocial factors connected with back pain and disability include the degree of control the worker feels he or she has over workload, the amount of job satisfaction experienced, feelings of stress, attitudes and beliefs about illness and relationships with coworkers. (16,35)

LBP is particularly common in the nursing profession and in health care workers in general, and psychosocial factors play just as great a role in the degree of disability resulting from a back injury. (38,46) Health care workers engage in activities that create dynamic loads that make them susceptible to LBP. These activities include lifting, pulling, pushing and carrying from twisted or bent forward positions. Dynamic loads such as these cause stress in the lumbar spine and make the area (including intervertebral disks) susceptible to deformity and mechanical damage. (38)

MR imaging was used in 1 study to compare degenerative lumbar spine changes in 2 populations of workers: nurses and administrative office

personnel. (38) Subjects were all older than 45 years and had been working in their respective professions for more than 20 years on average. Nurses predictably had more physically strenuous activities, lifted greater weights and were required to maintain bent and twisted postures. Administrative workers spent substantially more time in a static, seated posture. Thus, in the nursing population, the lumbar spine underwent dynamic work with high compressive loads; the lumbar spines of administrative subjects were subjected to static work with low compressive loads.

One goal of the study was to look at the natural degradation of intervertebral disks and to learn whether mechanical work stress might accelerate that aging process. More than 50% of both work populations displayed disk herniation. Surprisingly, there was no difference between the 2 groups in the occurrence of disk degeneration. Researchers concluded that some mechanism other than load-induced degenerative changes in the lumbar spine must be responsible for the high prevalence of LBP experienced by nurses. Furthermore, MR proved too sensitive with respect to revealing degenerative findings that were not connected to any pain reported by test subjects. (38)

A recent Belgian study of back pain in health care and distribution workers concluded that psychosocial work factors were not predictive of LBP. (6) Instead, 2 physical aspects of work were clearly related to LBP: more than 2 hours per day of working with the trunk in a bent and twisted position and an inability to alter position regularly. This study is important because it also revealed that pain-related fear nearly doubled the risk for a new LBP episode. The study authors suggested that work-related back pain might be reduced by addressing ergonomic aspects of job duties along with fears concerning pain. By means of education, workers' misconceptions about pain and the impact of LBP might be corrected and they might receive reassurance concerning the degree of disability that could result from a subsequent LBP incident.

Some researchers have employed a Fear Avoidance Belief Questionnaire to analyze test subjects' beliefs concerning how physical activity and work affect LBP. (12) Understanding beliefs about fear and what activities must be curtailed to avoid further or additional injury to the back could help identify workers who might, due to these beliefs, have a longer disability and greater rate of absence from work.

A 2-year study conducted by the National Institute for Occupational Safety and Health examined the use of back belts, which are wide elastic belts tightened to pull in lumbar and abdominal muscles in an effort to prevent LBP. (5) Back belt users will be interested to know that the researchers concluded that the use of back belts did not reduce the incidence of LBP.

Spinal Tumors and Infections

Both tumors and infections of the spine typically have a subtle--as opposed to sudden--onset of pain that grows persistent with time. (29) Fever, upper lumbar or thoracic back pain, local tenderness and nonpositional pain are possible indicators of vertebral infection. Spinal tuberculosis (TB), which is the most common form of tubercular skeletal involvement, is on the rise, given the resurgence of TB. (47) In many parts of the world, TB is still a major cause of skeletal infection and a common cause of back pain. Back pain is the primary symptom of spinal TB.

In adults older than 50 years, cancer accounts for about 7% of back pain. (26) In the later stages of the disease, many cancers metastasize to the spine. (48) Sometimes, asymptomatic spinal tumors are discovered only by chance on bone scans ordered to confirm a diagnosis of arthritis. (48) Red flags for cancer include a prior history of cancer, back pain that is constant and that disturbs sleep, unexplained weight loss of more than 10 pounds in 3 months, and back pain that continues or progresses despite treatment. (26) Simple blood tests can assist the physician in ruling out cancer as a cause of back pain; patients with cancer are more likely to be anemic and to have an elevated erythrocyte (red blood cell) sedimentation rate. (20,29,41)

Spinal Conditions in Elderly Patients

Accurate diagnosis of back pain is even more complicated in the elderly population because more possibilities exist, including a higher incidence of malignancy. (26) Physical examination is considered to be more critical in this patient group due both to the frequency of other, contributing illnesses and diseases and the range of possible diagnoses. Imaging is used sooner and more frequently with elderly patients, although there is an even greater incidence of identifying asymptomatic conditions with increased patient age. (29)

Psychosocial factors can play a larger role in back pain in older patients. Back pain might threaten the ability to perform daily living activities and substantially limit independence. The patient's willingness to adhere to treatment can be affected by the supervening needs of the patient's spouse, or the ability to comply with treatment recommendations can be affected by cognitive impairment such as dementia. (26)

Disk degeneration is a normal, predictable result of aging. (38) The water content of vertebral disks decreases with age, and this lessens disks' ability to absorb shock. Disk height may be reduced, and the chances of herniation increase. (49) A recent study demonstrated that radiographs could detect early stages of disk degeneration, while MR could detect only more advanced stages. (50) In another study of women aged 45 to 62 years, more than half of test subjects showed disk herniation on MR, with bulging being the most frequent form of herniation. (38) It has therefore been argued that radiographs are a more cost-effective, noninvasive method of detecting early disk degeneration, while MR imaging is too sensitive with respect to degenerative changes because it regularly reveals anatomical problems that are either asymptomatic or unrelated to a patient's symptoms. (38,30)

Osteoporosis, a condition in which the bones become porous and fragile, is the result of bone mineral loss. (20,51) The condition can be accompanied by pain, particularly in the lower back, deformities (such as the "widow's hump" or loss of height) and fractures. (20) Osteoporosis may be congruous with age or it can appear in younger patients as a result of some other cause, such as steroid use in patients who have asthma, rheumatoid arthritis, lymphoma or obstructive airway disease. (51)

Vertebral compression fractures, in which the vertebra is compressed and loses height, are a common cause of back pain in elderly patients even though many of these types of fractures are asymptomatic. Approximately 16% of postmenopausal women experience 1 or more compression fractures during their life times. (52) More than 700 000 compression fractures associated with osteoporosis are diagnosed in the United States each year, leading to 115 000 hospitalizations and 161 000 physician visits. In elderly patients, these fractures are a leading cause of disability and even death. (51)

Osteoporotic fractures usually are seen in the lower thoracic and lumbar vertebrae and are accompanied by the following symptoms:

* Pain from acute fractures that comes on suddenly, is intense and usually lasts from 2 weeks to 2 months.

* Pain that is felt deep within the site of the fracture, often with tenderness upon palpation over the involved vertebra.

* Pain that is worse when walking or standing and relieved by lying down.

* Pain that may radiate to the flank, abdomen or legs.

* Difficulty walking that may last for up to 2 weeks and limit activity for up to a month. (29)

LBP in elderly women also can be attributable to osteoporotic fractures of the sacrum. This type of pain occurs spontaneously and often is felt in the hip or buttock area. (29)

Osteoarthritis is another condition commonly found in elderly patients and is a likely culprit for back pain. Spinal osteoarthritis, also referred to as spondylosis, is a degenerative disorder that can cause a loss of normal spinal structure and function. (49) The 4 facet joints of each vertebra are covered with cartilage, which provides a lubricating, reduced-friction gliding surface. In elderly patients, this cartilage degenerates, often resulting in the formation of bone spurs (osteophytes) and osteoarthritis. (49) Osteophytes can cause nerve root compression and may interfere with the vertebral blood supply. They also can result in spinal stenosis, which is a narrowing of the spinal canal (the openings in the vertebrae through which nerves pass). (29,34) Stenosis causes back pain and sometimes leg pain. (34) Tumors and infections can mimic the symptoms of stenosis; thus, physicians must differentiate between these conditions, usually by means of imaging studies.

Spondylosis affects all areas of the spine. Cervical vertebrae, which permit a wide range of motion when healthy, are particularly susceptible to arthritic changes that can manifest as neck pain with radiating pain in the shoulder and down the arms. Forward bending and hyperextension can bring on pain associated with arthritis in the thoracic vertebrae. Because the lumbar spine bears most of the body's weight, degenerative arthritis that diminishes the structural integrity of this section of the spine can cause morning stiffness and pain, pain following prolonged periods of sitting and pain with repetitive movements such as lifting and bending. (49)

Back Pain in Children and Adolescents

Back pain is much rarer in children than in adults, but incidence of the complaint gradually increases with age. Prevalence rates vary from 1% to 72%, depending on various factors and the studies cited. General agreement indicates that by age 15, prevalence approaches that of adults. Back pain rarely disables children and adolescents. Unlike adults, a definable cause for the back pain can be found in more than 50% of pediatric patients, yet most children with back pain do not present for medical attention. (18,53,54)

Literature about LBP in children and adolescents is limited, but awareness of the problem has increased in recent decades. (55) Although causes of back pain and problems in children and adolescents can be attributed to developmental abnormalities, inflammatory or infectious diseases or spinal tumors, new attention also has been paid to mechanical problems and injuries affected by lifestyle factors. In the past, back pain in children often signaled a serious underlying disorder, but more recent studies are demonstrating the role of physical fitness and inactivity in LBP among adolescents in particular. (53,56)

Diagnosing back pain in children requires a thorough medical history and a physical examination to ensure that the pain does not arise from an underlying pathology such as a tumor or infection. (54) Various imaging techniques can be used along with the medical history to determine the cause of pediatric back pain.

Developmental and Mechanical Abnormalities

Spondylolysis and spondylolisthesis often are causes of LBP in children and adolescents. Spondylolisthesis is a vertebral defect that involves a vertebra slipping forward over the segment beneath it. Heredity predisposes some children to these conditions. Children and adolescents who participate in activities with repetitive hyperextension and rotational loads to the lumbar spine, such as diving and gymnastics, also are more susceptible to spondylolysis, much like young adults. (57) Stress fractures also can occur during adolescence from activities such as soccer, football, weightlifting and rowing. (58)

Spondylolysis rarely occurs before age 6 years. By age 6, reported incidence reaches about 5%--similar to occurrence in the adult population. (57) Pain from spondylolysis generally is mild and may radiate to the buttocks and legs, worsening with activity and improving with rest. The child also may walk with a short stride and stiff-legged gait. (53) Spondylolysis most often occurs in the L-5 vertebra, but also has been noted at higher lumbar levels. In children and adolescents, spondylolisthesis most often occurs at the L5-S1 juncture. (57) If spondylolisthesis is severe, it can lead to a narrowed spinal canal and pressure on the nerves. (53)

Growth spurts also can lead to stress fractures. (53) The increase in reporting of back pain that correlates with age becomes more frequent with puberty, particularly in adolescent girls. (59)

Scoliosis affects only about 2% of the population, with the majority of cases being idiopathic. This side-to-side spinal curvature can occur in children with cerebral palsy, muscular dystrophy, spina bifida or other conditions. However, most cases occur in otherwise healthy children and adolescents. The condition rarely causes pain in younger children, but may be diagnosed by signs such as uneven shoulders, an uneven waist, a slight lean in posture or a prominent shoulder blade. (60) Some types of scoliosis can cause back pain. Age of onset and back pain are risk factors for neural axis abnormalities among pediatric patients with idiopathic scoliosis. (61)

Scheuermann disease, or juvenile kyphosis, is a common cause of middle back pain in adolescents. Kyphosis, which is a rounded or hunched back caused by wedged vertebrae, most often occurs in elderly patients. But adolescents also can develop kyphosis, particularly boys aged 14 to 17 years

who participate in sports such as weightlifting or football or those who do heavy labor. (53,54,60)

The Role of Physical Activity

Increased and decreased physical activity have been associated with higher incidence of back pain in children. (18) Although conditions such as spondylolysis and spondylolisthesis can be considered developmental abnormalities, back pain in many pediatric athletes can be traced to repeated spinal loading caused by specific activities (see Figure 3). (57) Some back pain and injury also can be traced to a single traumatic event. Studies report that adolescent and child athletes are more susceptible to back pain and back problems than has been reported previously. (62)

Lack of physical activity also can lead to back pain in children and adolescents, though the effect of inactivity still is under study. Computer use also can cause back and neck pain. A study in Finland showed that neck, shoulder and back pain increased among adolescents beginning in the 1990s continuing through 2000. World Health Organization studies also began showing increasing back pain complaints in adolescents as the 1990s progressed. The timing of these increases corresponds with a rise in the use of communication technology, most notably computers, among adolescents. The Finnish study showed a higher risk of LBP among adolescents who used the computer or played digital games more than 5 hours a day. (63) However, a school-based questionnaire administered in the Netherlands in 2002 and 2003 related back and other musculoskeletal pain among adolescents to depression and stress, but not to computer use and physical activity. Little information exists in the literature about the use of computers and back pain among children and adolescents. (64)

[FIGURE 3 OMITTED]

Recent research on children has focused on back pain related to carrying heavy school backpacks. A 2006 report by Skaggs et al found that 37% of middle school children reported back pain, which was consistent with previous studies for the age group. The study also confirmed a trend of girls reporting more back pain than boys (43% vs 32%). (18) Contrary to other reports on pediatric back pain, younger children reported more pain. This may have been due to the fact that in this study younger children carried heavier backpacks, measured as a percentage of body weight, than did adolescents. (18) Experts generally recommend safe load limits of 10% to 15% of the child's body weight. Children make postural adjustments to carry these heavy loads and frequently lift and lower the loads throughout the day. (65) These activities cause repetitive stresses and injuries. The U.S. Consumer Product Safety Commission estimated that more than 13 260 injuries related to backpacks were treated by medical providers in 2000. (5)

Spinal Tumors and Inflammatory and Infectious Diseases

Spinal tumors are rare in children, but it is important to determine when they are the cause of back pain in pediatric patients and to distinguish benign tumors such as bone cysts from malignant masses such as osteosarcoma or metastatic lesions. Most tumors are benign but may require therapy to prevent functional impairment. Spinal tumors usually present in the middle or lower back; up to 96% of children diagnosed with bone tumors of the spine initially report back pain. (53,66)

Back pain from tumors tends to be focal and occurs at night, often waking children from sleep. The pain can increase over time and can be unrelated to activity. If pain is severe or its intensity increases rapidly, it may signal malignancy. Back pain also can signal a spinal cord tumor. Children with intramedullary tumors often present with scoliosis, a gait abnormality or other neurologic abnormality. Children with spinal tumors often develop spinal deformities such as scoliosis or kyphosis due to nerve root irritation, muscular responses to pain or asymmetric vertebral destruction. (66)

When children seek medical attention for back pain, the provider must determine that the pain does not originate from an underlying pathology. Other symptoms such as fever can signal an infection or inflammatory disease. Juvenile rheumatoid arthritis can cause musculoskeletal pain. Infections such as discitis or vertebral osteomyelitis can cause back pain, along with fever, poor appetite and irritability. Discitis is more common in young children, while vertebral osteomyelitis occurs more often in children older than 8 years. (53,54)

Diagnosing Back Pain

Given the multifaceted presentation of pain and the individuality of the pain experience, physicians need other sources of information to correctly identify the source of back pain. An accurate diagnosis is essential for effective treatment of certain back conditions, such as cancer. (67) Prior to ordering any imaging study, the physician will take a patient history and conduct a neuromuscular physical examination. A careful medical history in which the patient is asked to describe the onset of the pain and its duration, severity and location will help to identify any red flags. (5,10) The physician will note any limitations to movement and any medical conditions that might be related to the pain. A previous history of back conditions is relevant; a history of prior lumbar spine injury, for example, has been found to be the single most significant predictor of further lumbar injury in athletes. (10)

Imaging has its limitations. Studies consistently have shown that imaging reveals just as many abnormalities in individuals who are not experiencing back pain as in patients who present for diagnosis of back pain. (17) By the same token, many patients who complain of back pain have completely unremarkable imaging studies. For these reasons (as well as pressures to reduce medical costs), physicians often resist ordering any imaging studies until back pain has persisted for some time unless there are red flags that call for immediate investigation.

The American College of Radiology (ACR) Appropriateness Criteria rate the appropriate use of imaging for LBP associated with various clinical conditions. The criteria also define indications of a more complicated nature, referred to by clinicians and the literature as "red flags" (see Table 2). When red flags are present, radiographs usually are recommended. Uncomplicated LBP does not warrant any imaging studies. The challenge for the clinician is to determine which patients should be evaluated further because of suspicion of a serious problem. (69) More and more studies are being conducted to assist physicians in their approaches to the use of imaging to diagnose back pain. Radiographs readily show degenerative changes, but they do not provide a definitive answer concerning which structural abnormalities are asymptomatic and which are responsible for the pain. (2) Table 2 Red Flags (3,19,29,68,69) These conditions are likely to support the more immediate use of imaging for evaluation and diagnosis: * A history of cancer. * Unexplained weight loss. * Pain that is insidious in onset, progressive, nonpositional, associated with night pain and

systemic symptoms or signs. * Chronic, unremitting pain lasting more than 6 weeks. * History of recent, significant trauma. * Recent mild trauma in patients older than 50 years. * History of osteoporosis. * Patients older than 70 years. * Unexplained fever. * Immunosuppression. * Focal neurologic deficit. * Intravenous drug use or prolonged use of corticosteroids.

Improvements in CT and MR scanning in the past decade have not only led to better specificity, but also to some early, indiscriminate use of these more expensive imaging procedures for diagnosing uncomplicated LBP. Because nonspecific lumbar disk abnormalities are common and readily seen on myelography, CT or MR images, they might be detected in asymptomatic patients.

CT provides excellent bony detail, but multiplanar MR better depicts disk protrusions. In complicated LBP, MR of the lumbar spine has become the initial imaging method of choice, particularly with short-time inversion recovery (STIR) and fat-saturated T2 fast-spin echo sequences. (69,70) Spine MR has several advantages over other spinal imaging examinations. MR does not use ionizing radiation, which is particularly important in the lumbar region where gonadal exposure is a concern. On radiography and myelography, the spinal cord, nerve roots and disks can be located and their morphology inferred. But with MR, these structures can be visualized directly and better soft tissue contrast is possible. Some patients have contraindications to MR, and metallic hardware in the spinal area can limit MR's usefulness. (71)

Controversies Concerning the Use of Imaging To Diagnose Back Pain

Imaging is expensive. Targeted diagnostic imaging conserves resources while also providing needed information. Much current research in this area focuses on which imaging studies are cost effective and helpful and which types of imaging only confuse the patient's medical picture. Often, the determining factor is where back pain is located and whether the patient's condition or medical history raises any red flags.

Still, when it comes to which specific imaging studies should be ordered for various back conditions, a considerable amount of flux among researchers and those who draft practice guidelines remains. In the United Kingdom, for example, the Royal College of General Practitioners and the Royal College of Radiographers suggested that radiography is not indicated in acute back pain (ie, less than 4 weeks' duration) in the absence of red flags. (15,70) The ACR agreed. (69) In a study designed to discover whether radiography of the lumbar spine in patients whose pain had lasted in excess of 6 weeks resulted in improved outcomes, researchers achieved rather surprising results: The patient group that underwent radiography actually had a longer duration of pain, reduced functioning and more severe pain than patients who had not been imaged. (15) These results led scientists to theorize that radiography actually encouraged or reinforced the patients' belief that they were unwell and those beliefs led patients to report higher pain levels and to limit their daily activities.

Others indicate that radiographs are "generally required to ascertain a diagnosis for low back pain," while at the same time acknowledging that the lumbar spine is a difficult area for radiological identification of benign tumors; thus, radiographs ultimately might be misleading. (3) Sometimes, physicians allow time to pass before following up on studies that failed to reveal any abnormality. Similarly, practitioners report that it is often difficult to correlate LBP with structural changes in the spine seen on MR. As emphasized by appropriateness criteria, healthy, asymptomatic individuals also have a high prevalence of structural changes. (42,69)

In Carragee's 5-year study of LBP, examiners recruited subjects who had no history of LBP and then performed baseline MR imaging of each subject. Every 6 months, test subjects were interviewed. If a serious LBP episode justified a new MR, the procedure was ordered and the results compared with the baseline examination. Final study results indicated that MR after serious LBP episodes associated with minor trauma rarely demonstrated any new, significant findings. These results support the belief that imaging for diagnosis of back pain without red flags more often than not only reveals degenerative changes that were previously present and asymptomatic. (42)

Scientists have made some headway in terms of setting standards for which imaging studies might prove most helpful in relation to reported pain, the site of pain and other clinical findings. The following discussion addresses those standards in the context of patients according to age and presentation.

Imaging Back Pain in Athletes

Which imaging procedures will be appropriate for diagnosis of the injured athlete depends upon the patient history and conclusions drawn by the physician following a thorough physical examination. Generally speaking, radiographs are indicated to rule out structural abnormalities, and oblique images in addition to flexion/extension radiographs might be useful. (10) When lumbar pain has lasted for more than a week, posteroanterior (PA), sagittal and 45[degrees] angle right and left radiographs can help determine the cause. (40)

When radiographs do not provide sufficient detail, CT might be used to explore bony anatomy. CT scans provide information on the condition of any bony defect. (40) MR is most useful in evaluating disks, neural elements and other soft tissues, and it can help to identify occult fractures and tumors. (10) Radicular pain and low-velocity trauma can indicate the need for MR imaging of the lumbar spine, as well as radiography of the lumbar spine. (71)

Some practitioners assert that the "gold standard" for diagnosis of young athletes with LBP is bone scintigraphy with single-photon emission CT (SPECT). (39) However, MR imaging is as sensitive as SPECT at identifying stress fractures while at the same time sparing the patient the radiation exposure. (39) Bone scans also might be used to look at any metabolic activity (such as tumor growth) to help determine the age of bone fractures and to review arthritic defects. (10,40)

Imaging Trauma-induced Back Pain

Recent significant trauma is an indication for radiography or MR imaging. (69) CT of the spine may be the first imaging choice for acute spine trauma. In spinal CT, contiguous or overlapping axial slices are preferred with slice thickness depending on the region of interest. (72)

The intervertebral disks also are vulnerable to trauma, and imaging techniques may be required to make a distinction between disk pain and other types of pain because conventional physical exams cannot differentiate. (2) The internal structure of the disk can be disrupted, and fissures seen on CT images increasingly are associated with disk-related back pain. In 1 study, CT scans revealed that 39% of patients who had suffered from

chronic LBP associated with motor vehicle accidents and work-related injuries met the criteria for internal disk disruption. (2) Radiographs can demonstrate a loss of disk height, and MR can be quite useful in revealing loss of disk hydration, which is a sign of lumbar disk degeneration, on sagittal T2-weighted images. (10)

MR in thin sections of 3 mm or less may be used as the primary imaging tool to image the pars. On MR images, the appearance of spondylolysis varies depending on the lesion's acuity. Acute stress reactions show increased signal intensity on STIR and T2-weighted images in the pars, which indicates marrow edema. Chronic pars defects show reactive sclerosis, which may be represented by decreased signal intensity on T1 and STIR sequences (see Figure 4). (70)

Imaging Occupational Back Pain

For some physicians, MR has become the "gold standard" for diagnosing low back injuries. Various experts claim that MR can be used to distinguish between workers' conditions as a result of the aging process vs those due to a work-related injury. (11) They argue that the savings in workers' compensation claims would easily justify the expense of ordering MR examinations for each claim of work-related disability. Furthermore, those touting the advantages of early MR screening of injured workers claim that such a practice would result in faster cures, lives saved (for those who are diagnosed with spinal tumors) and quick disposal of questionable claims. (11) Other experts claim that using MR imaging to look for new pathology is rarely clinically helpful; that follow-up MR for new, serious LBP does not reveal any new structural changes; and that MR following serious LBP episodes and minor trauma rarely demonstrates significant new findings. (42) The ACR does not support MR imaging for uncomplicated LBP. (69)

[FIGURE 4 OMITTED]

Imaging Spinal Tumors and Infections

Spinal TB has a slow, nonspecific clinical and radiological presentation. Patients with spinal infection generally have a fever and localized back pain; some also present with neurological symptoms. (47,70) The results of a study conducted in Egypt in 2006 showed that radiographs failed to detect any significant tubercular lesion in more than 83% of patients who reported LBP that had lasted from 4 to 20 weeks. (47) The features of spondylodiscitis that indicate whether it is pyrogenic vs tuberculous might not be distinguished easily. CT and scintigraphy also can be used to diagnose spondylodiscitis, but MR provides the highest specificity and sensitivity. A return of fatty marrow signal in the endplates and a decrease in contrast enhancements on MR imaging help signal healing of the infection. However, contrast uptake still can occur at the site of the infection months after treatment begins, even though the patient is improving clinically. (70)

Primary bone tumors rarely occur in the spine. Radiographs and CT scans can help characterize some lesions, and scintigraphy helps identify lesions but is less specific than MR. Use of MR imaging allows assessment of the degree of soft tissue, cord and marrow involvement, which assists in staging. Benign lesions that must be distinguished from malignant tumors include osteoid osteoma, hemangioma, osteoblastoma, giant cell tumor and aneurysmal bone cysts. (70) Benign tumors tend to present without the red flags typically associated with cancer. Patients with benign lumbar tumors generally report a long history of increasing pain but do not display any neurological findings because a slow-growing tumor has additional "growing room" in the lumbar space. Pain might be worse at night when the patient lies down and nerve roots are forced to stretch over the tumor mass. (3)

Up to 12% of primary spinal neoplasms are chondrosarcomas. Patients with chondrosarcomas have pain, and nearly 50% present with neurological symptoms. On MR images, chondrosarcomas show low to moderate signal intensity on Tl-weighted sequences and high signal intensity on T2-weighted sequences. Focal low-signal calcifications might be observed, as well as extension into soft tissues with cord compression (see Figure 5). Other malignant tumors affecting the spine include chordoma, lymphoma and osteosarcoma. (70)

MR imaging, particularly with the STIR sequence, generally is the preferred imaging method for determining the cause of vertebral collapse. Benign conditions such as osteoporosis, trauma and benign tumors (hemangiomas and eosinophilic granulomas) can cause vertebral collapse. Malignant vertebral collapse can occur as the result of metastases or primary neoplasms. Marrow signal characteristics and the morphology of the collapsed vertebra help clinicians distinguish the cause. For example, involvement of the pedicles, which is determined by abnormal signal or change in morphology, is a feature that often signals malignant vertebral collapse. This determination can be difficult, particularly in elderly patients who have osteoporosis and a history of cancer. (70)

[FIGURE 5 OMITTED]

When metastatic cancer is suspected based on red flags or the results of blood tests, bone scans have proven to be a fairly sensitive diagnostic tool. (41) MR has greater sensitivity and provides better anatomic definition and specificity, but the cost is nearly twice that of a bone scan. Despite the relative cost, MR generally is accepted when a tumor or infection is suspected. (2) The Agency for Health Care Policy and Research guidelines support CT myelography, bone CT or MR imaging to aid in the diagnosis of back pain when a spinal tumor is suspected. (41) The ACR ranks MR of the lumbar spine as most appropriate for imaging when there is suspicion of cancer, infection or immunosuppression, followed by radiography of the lumbar spine or bone scanning. CT of the lumbar spine ranks slightly higher than radiography or myelography. (69)

Unfortunately, many patients with cancer who present with back pain of long duration are not diagnosed properly until an unacceptable amount of time has passed. One case that illustrates this point is "Anonymous," who wrote of the delays he experienced before his malignant sacral tumor was diagnosed. (73) This patient experienced 9 months of LBP and was referred by his general practitioner for radiographs. The radiologist reported that no abnormalities were found, although a later review of the films revealed a "very obvious" mass arising from a "missing" section of the sacrum. Another 7 months passed without diagnosis, and the tumor continued to grow. The patient recounted a return to his general practitioner who, relying upon the radiologist's report, suggested that the patient begin wearing boxer shorts to alleviate some symptoms (urinary frequency) and did not order any additional radiographs. Other symptoms appeared, and the patient's condition worsened, but an exam by a neurologist resulted in no diagnosis. An independent review of the patient's experience noted that the hospital had missed the tumor a second time on a myelogram and a third time on an MR image because the sacral area was not included, despite a neurologist's request that the entirety of the spine be viewed. (73)

Imaging Spinal Conditions in the Elderly

Most experts agree that radiographs are appropriate in patients older than 70 years and in particular for elderly patients whose condition has not improved in 4 weeks. (26,29) Radiographs can reveal degenerative disk and joint disease, compression fractures of the vertebrae, some tumors and infections, deformities and osteoporosis. (29) Spinal tumors can result in compression fractures of the vertebrae in both elderly and younger patients. (52) CT is valuable in assessing the bony structure of the spine, and MR is predictably superior in assessing soft tissue, including disks, ligaments, infection and tumors. (29)

The parameters for use of imaging are somewhat controversial in this patient population. While many argue that imaging should be used sooner, others claim that CT and MR are not indicated in older patients who do not exhibit any red flags. Those who argue in favor of extremely conservative use of imaging cite statistics supporting the conclusion that CT and MR demonstrate abnormalities in at least 50% of asymptomatic people older than 40 years. (26) Other studies have shown that as many as 57% of patients aged 60 years or older had abnormal spinal MR findings, and the prevalence of asymptomatic, abnormal disks is higher in elderly patients. (29) The ACR recommends lumbar radiographs as sufficient for the initial evaluation of osteoporosis and for patients older than 70 years. MR imaging of the lumbar spine without contrast also may be appropriate. (69)

When diagnosing vertebral compression fractures, radiographs will reveal compression fractures and dual energy x-ray absorptiometry scanning will reveal mineral content. (51) MR can provide additional detail, showing how compression fractures might be impacting surrounding soft tissue. (29)

Radiographs of suspected osteoporotic fractures of the sacrum are usually negative, but CT can show displacement of the bone. The pain from this type of fracture usually lasts 4 to 6 weeks, but patients have an excellent prognosis for recovery. (29)

MR can reveal facet joint osteoarthritis with moderate reliability. (38) Osteophytes currently growing show a high radiopharmaceutical uptake, while older or mature osteophytes tend to have at most a slightly increased uptake; for these reasons, radionuclide bone scintigraphy can aid physicians in discovering the relative state of degenerative changes. The sensitivity of these scans increases with the use of SPECT. (74)

Diagnosing Back Pain in Children and Adolescents

The physical examination and medical history, along with imaging, help determine the cause of back pain in children and adolescents. If onset of pain is acute, it may signal injury. More often, however, the onset is gradual. The clinician will document the relation of the back pain to specific physical activities, including a record of sports participation and other activities. Note will be made of symptoms that radiate from the back, any disturbance of bowel or bladder function and the time of day when pain occurs or worsens. The physical examination should include orthopedic and neurologic evaluation. (57)

Imaging children and adolescents introduces concerns about radiation exposure. These concerns become part of the decision to include imaging--and determine the modality used--in the diagnostic workup. Concerns of overexposure might factor into diagnosis and serial examinations during management. A combination of discriminate use of imaging, careful attention to technique and appropriate shielding can minimize radiation exposure for pediatric patients. (75,76)

With conventional radiography, standing posteroanterior and lateral radiographs of the thoracolumbar spine and supine oblique radiographs of the lumbosacral spine are most useful to assess children or adolescents with back pain suspected of arising from spondylolysis or spondylolisthesis. (57) As with young adults, CT and SPECT have been shown useful in detecting the defects of spondylolysis. Thin-section CT performed with a reverse gantry angle can define the bony anatomy of these conditions. (57,58) Campbell et al compared the use of CT and SPECT to MR in detecting defects from juvenile spondylolysis. The results showed that MR imaging was better at detecting certain types of pars defects, but was limited in the ability to accurately depict stress reaction and incomplete defects compared with combined CT and SPECT imaging. (56)

Diagnosis of scoliosis depends on the severity of the condition. Many schools sponsor scoliosis screenings. (60) Using spine radiography, erect PA images of the entire thoracolumbar spine should be obtained when imaging a pediatric patient for evaluation of scoliosis. Erect images should include the iliac crests. A lateral radiograph also may be obtained. When patients cannot stand, sitting films should be obtained using an anteroposterior technique. (77) Children with scoliosis might require frequent imaging, so radiation protection is important. Protection may include lead-acrylic filters, breast shields (especially for AP examinations), increased beam filtration, high-speed films and screens and beam collimation. Gonadal shielding can be used when the area of curvature does not include the sacrum. (78) MR imaging can be used to investigate risk factors for neural axis abnormalities in certain patients with scoliosis. (61)

Many children with spinal bone tumors have other abnormalities identified on initial radiographs. Scoliosis, kyphosis and congenital vertebral anomalies are among the abnormalities identified. Ewing sarcoma is a possible malignant diagnosis in all pediatric patients. In young children, possible malignant spinal tumors also include leukemia and metastatic neuroblastoma or Wilms tumor. Osteosarcoma is a common malignant spinal tumor in children aged 5 to 15 years. Benign causes of spinal tumors in children include bone cysts and osteoblastoma. Clinical history and physical examination can suggest a spinal tumor, and imaging can help the clinician make an informed diagnosis. Radiographs can provide ample information for diagnosis, but cross-sectional imaging is preferred for full evaluation. MR imaging is particularly helpful in localizing spinal cord tumors.

[FIGURE 6 OMITTED]

Ewing sarcoma usually appears as vertebral destruction with a soft-tissue mass; epidural Ewing sarcoma might not be visible on radiographs. Osteosarcoma typically appears as a bone-forming, radiodense destructive mass. Extensive soft tissue masses often indicate spinal malignancy (see Figure 6). (66)

Radiography can show changes to bone and vertebral compressions to suggest possible infectious or inflammatory causes of back pain. Often,

infections such as discitis and vertebral osteomyelitis can be distinguished from tumors by the narrowing of disk spaces in spinal infections. (66) Skeletal scintigraphy with technetium 99m radiopharmaceuticals or SPECT imaging can best reveal osteomyelitis. (54,79) On MR imaging, infection shows decreased signal intensity of the vertebral body on T1-weighted images and increased signal intensity in the intervertebral disk. (66)

Imaging the Patient With Back Pain: Special Considerations

Controversy concerning the use of imaging for back pain requires careful documentation of referral and medical necessity. (15,69,72) The request for examination must originate from a physician or other appropriately licensed health care provider. Medical necessity documentation should include signs and symptoms, as well as known diagnoses or other relevant clinical history. (72)

When performing CT of the spine, slices should be no thicker than 3 mm. (72) Personnel should be familiar with special considerations associated with recently implanted spinal hardware. Knowing the composition of orthopedic hardware prior to CT examination helps the technologist set technical parameters to minimize both radiation exposure to the patient and artifacts caused by the devices. For example, titanium has a lower density than stainless steel. (80)

MR imaging of patients with recent spinal hardware implantation poses special considerations and potential hazards. (71) Dedicated coils and standard protocols should be used when performing MR spinal examinations. (81)

Patient positioning is important to ensure proper spinal position, minimize exposure of other anatomy to the beam and ensure immobilization. Patient comfort also is important for patients with back pain, particularly in delayed and lengthy imaging procedures. A pillow or specially designed pad can be placed under the knees to help patients with low back pain feel more comfortable. (80,82)

The Role of Imaging In Back Pain Management

There is no shortage of studies motivated by the need to discover which modes of treatment are most helpful to back pain patients, whether traditional or alternative treatments prove more effective and whether simple approaches like education and exercise might be the most expedient "cure" for back pain. Forces driving these studies include patients' chronic pain, the high incidence of back pain and its costs to society, and the pocketbooks of insurance companies. Imaging plays an important role in studying the efficacy of different treatments and in assisting with the application of some treatment interventions. For example, some researchers contemplate using diffusion tensor imaging to determine whether certain drugs aimed at specific neurotransmitters are affecting patients and their recoveries. (83)

It bears repeating that the majority of individuals who suffer from LBP enjoy significant, rapid improvement in the complete absence of any treatment. (84) The goals of treatment for any back condition are relief of symptoms (primarily pain) and improvement in functioning, along with prevention of recurrence and chronicity. (7,26) Treatment should be tailored to the individual patient; many experts theorize that there are subgroups of patients with back pain who respond more favorably to 1 form of intervention over another. (31)

In elderly patients, for example, the treatment efficacy of exercise is not well studied, and there may be concerns about patient safety; for these reasons, physicians might instead choose more passive treatment options, such as ultrasound, massage and ice. (26) Often, when associated depression and poor sleep are treated, the patient's pain level and mood improve, so medications other than analgesics might be considered. (26) Whether pain is acute, chronic, severe or moderate also defines treatment options, as do the diagnosis and whether it is tentative or confirmed clinically or by means of imaging studies (see Table 3). The intensity of the patient's pain is another consideration, because it should drive the choice and dosage of medication. (22)

Treatments prescribed by physicians or sought by patients include:

* "Passive" treatments such as ice, heat, ultrasound, short bed rest, biofeedback, transcutaneous electrical nerve simulation and braces.

* Exercise.

* Medications such as analgesics, anti-inflammatory, antidepressants or sleep aids.

* Chiropractic manipulation or traction.

* Acupuncture.

* Massage therapy.

* Minimally invasive procedures such as injections, vertebroplasty or interventional therapy such as nerve blocks.

* Surgery such as discectomy, foraminotomy or spinal fusion. (5,7)

Scientists on the frontiers of pain study are looking at whether or not certain genes are linked to pain and how it is experienced. As a result, perhaps one day treatments will be designed at least in part based on a patient's genetic profile. (13) Imaging (in particular fMR) is assisting scientists in efforts to look at individual patients' pain experiences by visualizing different pain states and patients' response to therapies. (28) Current studies support the hypothesis that patients with the greatest pain, disability and psychological distress levels have the poorest chance of recovery. (44)

Most LBP can be treated without surgery, using analgesics, anti-inflammatory drugs, ice and heat to reduce pain and inflammation. Bed rest, once routinely prescribed, is no longer recommended for longer than 1 to 2 days. Indeed, bed rest for longer periods of time is contraindicated because it can cause complications such as depression, decreased muscle tone, loss of flexibility and blood clots in the legs. (5) Consensus within the medical

community is that most patients with back pain should be encouraged to return to normal activities as soon as possible to avoid pain-related disability. (21,31)

Similarly, the use of braces and back corsets increasingly is disfavored. (21) Braces may offer advantages in terms of controlling excess movement (and thus pain), but long-term use can result in muscle wasting, which only exacerbates the back condition. (10) Braces, however, may prove useful as a physical reminder to the patient that using correct spine mechanics during lifting and bending activities is important. (7)

No matter what current treatment guidelines specify, studies have shown that many general practitioners do not practice according to the guidelines; they instead respond to their patients' wishes or desires, no matter how misinformed those patient preferences may be. (46) For example, although guidelines for managing acute back pain do not include time off from work as a primary intervention in most cases, physicians liberally prescribe days off for their patients. The authors of 1 study theorized that it is easier to prescribe time off from work than it is to take the time to explain to a reluctant patient that evidence indicates it would be better for him or her to return to usual work activities as soon as possible. (46)

It is important, then, to educate both medical care providers and patients with respect to back problems, pain, limitations and treatment options. "Back schools," in which patients are taught proper body mechanics, among other things, have not been demonstrated to prevent LBP, but some evidence indicates they are helpful when combined with other treatment efforts. (7) In other studies, providing patients with back handbooks reduced patients' reliance on health care professionals. (31)

Physical Therapy and Exercise

One of the most frequently used treatment modalities for chronic LBP is exercise, often under the guidance of a physical therapist (at least initially). (86) The goals of exercise include managing chronic LBP by strengthening certain muscle groups, increasing flexibility and endurance, restoring injured tissues and permitting patients to return to a more normal, active lifestyle. (86) Low-impact aerobic activities might not affect the back condition directly, but they can improve mood, increase pain tolerance and prevent deconditioning. (7) Enhanced endurance of trunk muscles even can prevent the onslaught of back problems.

Studies present differing conclusions regarding the length of physical therapy and exercise training programs and improved strength and flexibility. Some studies conclude that intensive exercise must continue for more than 2 months before significant pain reduction is achieved, while others report that a 3-week daily exercise program is equally efficient. (86) Exercise programs should include the following components: flexibility to prevent muscles from shortening and tightening, strengthening to increase strength and lean muscle mass and aerobics to help the body work more efficiently and increase stamina. (25) Exercises also can be designed to improve posture and coordination. (5) For some patients, unfortunately, improvements in strength and flexibility do not always bring about a reduction in pain. This puzzling result may be due to psychosocial factors that are not addressed or benefited by an exercise program. (86)

There are many reasons why simple exercise is often the best treatment for patients with back pain. Exercise causes the release of endorphins, which block pain signals from reaching the brain, and endorphins can reduce the anxiety and depression that often accompany chronic pain. (25) Regular exercise helps with sleep and weight reduction, lessening the stress placed on the back and joints. Even patients who demonstrate a high level of pain-avoidance--those who hesitate to exercise or engage in normal movements for fear of increasing their back pain--benefit from exercise programs, at least on a short-term basis. (8,31) Exercise might teach fearful patients that careful movement relieves rather than creates pain. Present studies of the efficacy of different exercise programs and physical therapy approaches indicate that the more "hands on" the program is (ie, the more involved the patient is in setting therapy goals), the better the results. (31)

Physicians sometimes advise patients to combine exercise and physical therapy with behavioral cognitive training as a means of addressing the social and psychological factors that often play a large part in causing or maintaining back pain. (16) As indicated in the preceding discussion, chronic LBP is influenced by psychological stress, illness behavior and patients' attitudes and beliefs. It is important to remember that pain-related fear nearly doubles the risk for a new LBP episode, making it of pivotal importance that such fears are addressed. (6) Behavioral approaches can include psychological, educational and social elements. Among male workers, one of the most significant predictors of LBP is low social support at work. (35) In some programs geared toward injured workers, behavioral approaches include counseling and even intervention at the work site through advocacy efforts such as addressing issues with work supervisors. (46) This multidisciplinary approach to chronic back pain has been proven to get patients back to work sooner, although the jury is still out when it comes to quality of life improvements and reduction of pain. (16)

Exercise also might be part of a postsurgical treatment plan. While surgeons have long sought to reduce trauma to the spine by reducing the invasiveness of surgical techniques (by using, for example, microscope-assisted or endoscopic techniques), researchers have attempted to improve surgical results by refining postoperative care. (12) The combination of patient education and specific exercise programs is being studied to determine what role a carefully planned exercise regimen might play in speeding up recovery after surgery and in prolonging the positive results of surgical interventions.

Minimally Invasive and Surgical Interventions

The most useful measure of a treatment's success, or lack thereof, is patient perception: Does the patient believe that a good result has been achieved? The patient's perception is influenced by the psychosocial factors already discussed; thus, a multidisciplinary approach--combining behavioral therapies with surgery--may be the most effective treatment plan for many patients. (21) A continuum of invasive and minimally invasive options is available, depending on the patient's condition and the physician's experience and diagnosis.

Currently, a debate has been going on between orthopedic surgeons and interventional radiologists regarding who the best specialist is when it comes to treating back pain, what techniques are the most promising and when they should be used. Imaging is being used to answer some of these questions, and it assists in identifying which patients are likely to benefit from which treatments.

Bone scintigraphy with SPECT was used in 1 study to determine which patients suffering from LBP would benefit from facet joint injections. (74) Because the facet joint is considered a source of much degenerative back pain, facet joint injections have been used to alleviate pain and determine

whether or not the facet joint really is the source of pain. Inconclusive results led physicians to try both CT and MR as a means of identifying painful facet joints. CT proved to be unreliable, and MR imaging has not been investigated sufficiently. (74)

Radionuclide bone scintigraphy, however, can detect bone areas with increased activity and depict degenerative changes. In 1 study, SPECT revealed patients who would have an excellent response to facet joint injections administered accurately at the level demonstrated by the scan results; patients who had negative bone scans could be spared the invasive joint injection procedure, which carries the possibility of infection and sensitivity to contrast material. (74)

Most disk herniations recover naturally--the bulging material is gradually reabsorbed, nerve roots overcome the irritation and pain decreases. (10) When symptoms of nerve impingement or impairment continue, however, physicians may consider a spinal injection, such as a nerve root block. Practitioners use fluoroscopy to guide injections and ensure that the injected drug (often a steroid to reduce inflammation and assist in pain relief) flows into the proper areas. (7,21) When injections fail, the next step may be a discectomy (removal of a disk or portion thereof). (10,20) Open surgery--the method used in the past to treat most herniated disks-has obvious, well-known disadvantages, including scarring, damage, infection and postoperative inactivity. (36)

Newer techniques, such as microscopic discectomies, limit invasiveness. Percutaneous discectomies are performed on an outpatient basis under light sedation and with guidance from radiographic landmarks. The procedure involves removing disk material by means of a probe and aspiration. According to a neuroradiologist who reports having performed more than 1158 of these procedures, safety is high, as long as the practitioner has a "thorough knowledge of and attention to radiographic landmarks for probe positioning" and is "at every moment ... absolutely sure of the anatomical position of the instruments, [which] ... requires perfect knowledge of the radiological projections, along with the ability to make a three-dimensional mental reconstruction from the flat, two-dimensional fluoroscopic image." (36) Discography or CT discography can help assess which patients are most appropriate for this procedure. Best results are had in patients aged 50 to 55 years, who are likely to experience a good reduction in disk pain.

Discectomies--whether done as open surgery or in a less invasive procedure--can be performed at several vertebral levels, depending upon the number of affected disks. The success rate for discectomies in the general population is high. Spinal fusions also are used to treat degenerative disk disease, although results are not consistent. (10)

Percutaneous vertebroplasty is an accepted treatment for fractures resulting from osteoporosis (see Figure 7). (51) In this minimally invasive procedure, some form of bonding agent (often acrylic cement) is injected into the porous vertebra to prevent further collapse and reduce bone deformation and micromotion at the fracture site. It is reported to reduce pain in 75% to 90% of patients and generally is recommended for patients whose osteoporotic fractures are less than 1 to 4 months old. (51) Increasingly, however, physicians are willing to perform the procedure on older fractures. MR and isotope bone scans are used to determine the age of the fractures, with MR being useful particularly for gathering functional and anatomical information. (52) The procedure itself often is performed under CT and fluoroscopic guidance. (51,52)

More invasive surgical techniques include spinal stabilization by means of hardware. Spinal radiographs are used to evaluate patients prior to surgery and to provide postsurgical confirmation of proper alignment of the spine and placement of hardware. Research results remain uncertain regarding the optimal treatment for chronic LBP patients for whom conservative treatment has failed; thus, current research studies often compare the most invasive, expensive approach to treating chronic LBP (ie, surgery) with other, less expensive, less invasive treatment modalities. In a recent British study that compared spinal fusion to intensive rehabilitation, there was no clear evidence that fusion was any more beneficial than intensive rehabilitation. (14) Some theorize that the ultimate results of surgery depend largely on patient selection and that success may be more a result of psychosocial factors than surgical prowess. (21)

Complementary Therapies

Complementary therapies such as acupuncture, massage, manipulation (by chiropractors) and yoga can be combined with more traditional approaches to treating back pain. Studies designed to determine the true efficacy of these therapies are numerous and increasingly refined in their approaches. However, results are varied.

Acupuncture is among the most common alternative treatments sought by LBP patients. (87) The theory underlying acupuncture is that precise insertion of needles triggers the release of naturally occurring painkilling molecules that keep the body's energy flowing freely. (5) In 1 study designed to explore the impact and cost effectiveness of acupuncture, chiropractic or massage therapy in patients with LBP, results indicated that offering patients access to a choice of 1 of these alternative therapies did not result in clinically significant improvements in symptom relief or functional restoration. Treatment costs were also predictably higher ($244 per patient), but patient satisfaction was much greater. Most patients chose massage over acupuncture or chiropractic treatment by a factor of 2 to 1. Other complementary medical therapies (eg, yoga, tai chi and mindfulness-based stress reduction) were not studied. (84)

[FIGURE 7 OMITTED]

Other study results reported in 2006 revealed that acupuncture resulted in clinically relevant benefits to patients with chronic LBP, as compared with patients who did not receive acupuncture treatments. Another published trial that compared massage to acupuncture showed that massage resulted in a better functional outcome but that it was less effective than acupuncture in terms of pain control. (87)

Because of concerns for the developing fetus, drugs that cross the placental barrier generally are not prescribed for pregnant women with back pain. Alternative medicine might provide relief for these patients. In a study of 72 pregnant women with LBP and pelvic pain, patients were divided into 2 groups: 1 received acupuncture and the other served as a control group. Of women in the acupuncture group, 60% experienced decreased pain intensity compared with 14% of those in the control group and 43% reported that pain induced by physical activities had been reduced compared with 9% of those in the control group. Another randomized, controlled study demonstrated that acupressure (a branch of acupuncture using firm pressure and stimulation) is a more effective alternative than physical therapy in reducing LBP. (37) Few adverse side effects are reported in connection with acupuncture. (7)

Whether or not manipulation and chiropractic are effective in treating back pain is unproven, although previous safety concerns have been disproved substantially. It is estimated that less than 1 in 3.7 million treatments results in clinical worsening of disk herniation. (21) Consensus guidelines from the Agency for Healthcare Research and Quality state that spinal manipulation within the first 6 weeks of back pain can reduce symptoms. (7)

Treating Back Pain in Children and Adolescents

Unilateral spondylolytic stress fractures are more likely to heal than bilateral fractures. Early detection and treatment can improve the outcome. The most effective nonsurgical treatment has been shown to be early immobilization with a brace. The treatment is continued until pain-free lumbar extension and rotation are achieved and repeat CT shows progressive bony healing. Physical therapy generally follows immobilization before normal activities can be resumed.

Pediatric patients with spondylolysis with a symptomatic defect will be treated to alleviate pain and improve spinal mobility, but not to promote bony healing. For most patients, a period of restricted activity and physical therapy will lead to a safe return to normal physical activity. Serial examinations and radiographs are used to assess patients after treatment if symptoms recur or for patients who demonstrate a change in clinical appearance.

Pediatric patients with spondylolisthesis also respond to nonsurgical treatment. Restricted physical activity, bracing and physical therapy are treatment options. Serial physical examination and radiographs might be performed on children with asymptomatic, low-grade spondylolisthesis as often as every 6 to 9 months until the child reaches skeletal maturity. Surgery generally is indicated only when a child has persistent pain from a stress fracture of the pars that does not heal, a spondylolytic defect or low-grade spondylolisthesis despite 6 months of nonsurgical treatment. Some patients will require surgical intervention if their conditions are more serious, such as when they present with neurologic deficit. (57)

Most scoliosis cases are mild and need only serial observation. If the curvature progresses, an orthopedic brace might be used to prevent worsening. Surgery might be used if brace treatment does not control the curve. (60) In more severe curvature and cases that involve neurologic findings, surgery may be needed to correct the curve. (61) Juvenile kyphosis treatment usually is nonsurgical and involves use of a brace as the child grows, casts if the curve is rigid and exercises to stretch and strengthen muscles. The exercises help relieve pain, but do not correct the hunched appearance of the back. (53)

Back pain, as well as the permanent effects on posture or spinal structure, from carrying heavy backpacks still is under study. To date, managing back pain from this activity focuses on physical therapy and on prevention by educating children, schools and parents about appropriate loads. (18,65)

Benign spinal tumors are followed clinically and radiographically to determine whether they resolve on their own. Some benign tumors require surgery to relieve symptoms. Children with confirmed spinal malignancy on biopsy generally receive chemotherapy to reduce tumor size prior to surgery. The surgeon will attempt en bloc resection with negative margins. The patient also might receive postoperative chemotherapy to eliminate micrometastases and postoperative radiation therapy if positive margins remain or if the tumor was deemed unresectable. (66)

Discitis generally requires several days of bed rest plus intravenous or oral antibiotic treatment based on the infection identified. Bracing for immobilization might be required if the infection has narrowed the disk space. In some cases, prolonged antibiotic therapy is required; surgical drainage of the infection rarely is needed. (53,54)

Conclusion

Imaging will continue to play a critical role in research aimed at understanding and managing back pain. (1,5) The specific use of imaging modalities within the regular clinical practice of back pain diagnosis undoubtedly will remain controversial for the near future, as various medical specialty organizations, payers and government entities continue to gather and debate data on outcomes and cost effectiveness.

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1. --is the leading cause of chronic pain.

a. Headache

b. Back pain

c. Arthritis

d. Osteoporosis

2. Much of back pain can be attributed to lifestyle choices, including:

1. obesity.

2. lack of exercise.

3. sedentary environments.

a. 1 and 2

b. 1 and 3

c. 2 and 3

d. 1, 2 and 3

3. More than--nerve roots enter and exit spaces between the vertebrae.

a. 30

b. 40

c. 50

d. 60

4. The vertebrae are divided into 4 groups, with the greatest number of vertebrae in the--section.

a. thoracic

b. lumbar

c. sacral

d. cervical

5. The core of a healthy intervertebral disk is composed of--% water.

a. 30

b. 50

c. 70

d. 90

6. Chronic pain can be defined as any pain that:

1. lasts more than 12 weeks.

2. recurs frequently.

3. lasts beyond a normal healing period.

a. 1 and 2

b. 1 and 3

c. 2 and 3

d. 1, 2 and 3

7. Pain that results from a motion or activity that stresses the soft tissues supporting the spine is known as--pain.

a. systemic

b. mechanical

c. neurogenic

d. osteoporotic

8. A study showed that pain-related fear nearly doubled the risk for:

a. a new episode of LBP.

b. spinal infection.

c. traumatic accidents leading to spinal injury.

b. death.

9. The highest prevalence of LBP is in people aged --to--years.

a. 10; 15

b. 25; 44

c. 45; 64

d. 65; 74

10. Men tend to report more severe and longer-lasting pain than do women.

a. true

b. false

11. According to the text, which types of athletes are at greater risk for LBP caused by degenerative changes?

a. tight-rope walkers and trapeze artists

b. gymnasts and divers

c. marathon runners and sprinters

d. rugby and soccer players

12. According to the article, health care workers are particularly susceptible to LBP because they engage in activities that create:

a. unsafe work places.

b. static work.

c. dynamic loads.

d. depression.

13. In adults older than 50 years,--accounts for about 7% of back pain.

a. tuberculosis infection

b. osteoporosis

c. cancer

d. work-related stress

14. A common cause of back pain in elderly patients in which a vertebra loses height is:

a. vertebral compression fracture.

b. spondylolysis.

c. scoliosis.

d. Scheuermann disease.

15. Spinal osteoarthritis, a degenerative disorder that can cause a loss of normal spinal structure and function, also is called:

a. spondylolisthesis.

b. spondylosis.

c. scoliosis.

d. discitis.

16. A vertebral defect involving a vertebral segment shifting forward over the segment beneath it is called:

a. spondylolisthesis.

b. spondylosis.

c. spinal stenosis.

d. discitis.

17. Juvenile kyphosis most often occurs in:

a. girls going through puberty.

b. children younger than 5 years.

c. sedentary children.

d. adolescent boys who participate in heavy lifting or football.

18. Experts generally recommend that children can safely carry backpacks that weigh between--% and--% of their body weight.

a. 5; 10

b. 10; 15

c. 15; 20

d. 20; 25

19. When children have focal back pain that occurs at night and wakens them from sleep, it may indicate:

a. spinal infection.

b. juvenile kyphosis.

c. scoliosis.

d. spinal tumor.

20. A history of cancer is a red flag for investigation of back pain.

a. true

b. false

21. Disk protrusions are better depicted with:

a. radiography.

b. bone scans.

c. CT.

d. MR.

22. When evaluating back pain in athletes, which imaging examination can demonstrate metabolic activity?

a. spinal radiography

b. CT scan

c. ultrasound

d. bone scan

23. A sign of lumbar disk degeneration that can be revealed on sagittal T2-weighted MR images is:

a. marrow edema.

b. disk dehydration.

c. low-signal calcification.

d. signal intensity in the pars.

24. MR signs that a spinal infection is healing include:

a. contrast uptake at the site of infection.

b. reactive sclerosis.

c. fatty marrow signal and decreased contrast enhancement.

d. low-signal calcification.

25. Up to 12% of primary spinal neoplasms are:

a. chondrosarcomas.

b. hemangiomas.

c. osteosarcomas.

d. eosinophilic granulomas.

26. When diagnosing vertebral compression fractures in elderly patients,--reveal mineral content.

a. radiographs

b. CT scans

c. myelograms

d. dual energy x-ray absorptiometry scans

27. Many schools sponsor--screenings for children.

a. backpack load

b. scoliosis

c. juvenile kyphosis

d. juvenile arthritis

28. Clinicians can sometimes distinguish tumors from vertebral osteomyelitis by noting--on radiographs.

a. bone displacement, indicating a likely tumor,

b. bone displacement, indicating a likely spinal infection,

c. narrowing of the disk spaces, indicating a likely tumor,

d. narrowing of the disk spaces, indicating a likely spinal infection,

29. To avoid pain-related disability from LBP, most patients should--as soon as possible.

a. be fitted with back braces

b. begin bed rest that lasts for a minimum of 2 weeks

c. return to normal activities

d. have trigger-point injections

30. Exercise provides many benefits in preventing and relieving back pain, including the release of --, which can reduce anxiety and depression and block pain signals to the brain.

a. pressure points

b. analgesics

c. endorphins

d. steroids

31. Most disk herniations require surgical treatment.

a. true

b. false

32. According to the article, percutaneous vertebroplasty is recommended most often for patients with:

a. kyphosis.

b. scoliosis.

c. chronic pain from neglected sports-related stress fractures.

d. osteoporotic fractures less than 1 to 4 months old.

33. The most common alternative treatment sought by LBP patients is:

a. aromatherapy.

b. acupuncture.

c. homeopathy.

d. behavioral cognitive therapy.

34. Which nonsurgical options are used to treat spondylolisthesis in children?

1. restricted physical activity

2. bracing

3. physical therapy

a. 1 and 2

b. 1 and 3

c. 2 and 3

d. 1, 2 and 3

35. Treatment for discitis in children usually consists of:

a. surgery.

b. exercise.

c. rest and oral or IV antibiotics.

d. surveillance with serial radiographs every 3 months.

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Reprint requests may be sent to the American Society of Radiologic Technologists, Communications Department, 15000 Central Ave. SE, Albuquerque, NM 87123-3909, or e-mail communications@asrt.org. Table 3 Treatment Options for Specific Back Conditions (2, 5, 7, 10, 17, 21, 29, 40, 82, 85) Spinal tumors Spinal radiosurgery, radiation therapy,

radionuclide therapy, chemotherapy, hormonal

therapy or surgical decompression followed by

radiation therapy. The goal of treatment is

to reduce pain, prevent fractures and halt the

progression of neurologic compromise. Spinal stenosis Treatment options are limited due to anatomical

changes but include analgesics, physical therapy,

epidural spinal steroid injections and surgery. Acute mechanical Analgesics (including topical ones) and back pain anti-inflammatories; gentle, progressive back

exercise program once acute pain has subsided;

physical therapy; temporary work reduction; or

spinal manipulation (within the first 6 weeks

only). Chronic mechanical Strengthening of back and abdominal muscles back pain to form a brace for degenerative back problems;

braces and corsets for external immobilization;

surgery (fusion of spine to prevent movement);

analgesics (oral and topical) and

antidepressants; massage therapy; spinal

manipulation (not as well studied as

in acute back pain); multidisciplinary

approaches that address psychosocial

aspects (eg, pain-related fears, workplace

stressors); trigger point injections (when

other interventions have failed); or

massage, acupuncture and other complementary

therapies. Compression Analgesics, spinal extension exercises or fractures vertebroplasty. Spondylolysis Exercise, braces (rigid and elastic for (degenerative stabilization, with varying time periods changes) for use), electrostimulation, rest from

sports activities or surgery when

conservative treatment has failed.

Surgical repair of the defect may include

wiring of the joint, screws and hooks to
fix the spine. Disk herniation Nonoperative treatments are first choice.
Medications might include anti-inflammatory
drugs, muscle relaxants (although some argue
there are no well-controlled studies to
support their use in disk herniations) or
antiseizure medications (for nerve pain).
Other nonsurgical treatments include physical
therapy (in chronic pain situations), bracing
(although literature does not conclusively
support this approach), steroid injections
(often guided by fluoroscopy) and trigger-
point injections. Discectomy is indicated
when pain and condition do not improve.
Spinal fusion is a poor treatment
option for athletes in particular and should
be tried only as a last resort.

NOTE: All illustrations and photos have been removed from this article.
