Lumbar DDD is manifest clinically by a spectrum of disorders, including disc extrusion with or without migrated fragment, disc protrusion, (central, paracentral, intraforaminal, or far-lateral) disc bulge, and internal disc disruption. Of these, frank disc rupture causing monoradiculopathy or cauda equina syndrome is a well-established entity. Very little, if any, controversy exists with regard to its clinical diagnosis or management, although there may be minor differences of opinion about the choice of options for treatment. In the past two decades, the syndrome of disc resorption without disc herniation has been recognized as a definable entity amenable to surgical treatment.11,12 Historically, disc rupture with monoradiculopathy was thought to be a clinical syndrome amenable to surgery, originating with the initial description of the syndrome by Mixter and Barr.30 Patients presenting with axial back-dominant pain but with minimal or absent radicular pain were not thought to be good candidates for surgical intervention. There have been advances in several related fields, including a better understanding of the anatomical, physiological, and biochemical features of pain generators in the intervertebral disc, refinements in the technique of lumbar discography, improved resolution in MR imaging, development of newer anterior approaches to the lumbar disc (open or laparoscopic), evolving concepts about the usefulness of bone morphogenetic proteins, and critical evaluations of surgery-related results following lumbosacral fusion. These advances are contributing to the rapid contemporary evolution in the understanding of discogenic pain syndrome.

Several terms have been applied to this discogenic pain syndrome and the differences are minor; these include trauma-induced internal disc disruptions, black disc disease, isolated disc resorption, and segmented instability.

CLINICAL SYNDROME

Discogenic back pain syndrome appears to be a disease of adulthood. Although disc disease is well recognized in teenagers and even younger children, the childhood syndrome is one of disc herniation at a single or multiple levels. The incidence of lumbosacral DDD is higher in young athletes such as gymnasts or ballet dancers, but in our experience, they present with disc herniation rather than black disc disease. This difference may be the result of age-related biochemical changes in the intervertebral disc.

The cardinal manifestation of internal disc disruption is back pain. Although a patient’s description may suggest diffuse low-back pain, we have found that when specifically questioned and asked to run a finger horizontally across the back at the site of maximum pain, the accuracy of this pain localization matches that defined by MR imaging in approximately 80% of the cases. This observation may be related to the segmental nature of innervation of the anulus, which is the most pain-sensitive structure.23 O’Brien35,36 has observed focal tenderness at the anterior lumbosacral region with transabdominal palpation. He attributed this to the rich innervation of the anulus, which is most pain-sensitive structure.23 O’Brien35,36 has observed focal tenderness at the anterior lumbosacral region with transabdominal palpation. 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Abbreviations used in this paper: DDD = degenerative disc disease; MR = magnetic resonance; PLIF = posterior lumbar interbody fusion.
we have encountered patients reporting radiating pain in the nerve root distribution but have found no evidence of objective root deficit; even if a deficit is present, it is a blunting to pinprick sensation, but invariably there is no motor weakness. Straight leg raising tests or sciatica-related stretch tests consistently show no signs of abnormality. When the aching pain extends to the posterior thigh, it may be difficult to differentiate from facet joint origin. The use of differential blocks of the disc and facets in patients with back pain syndrome, however, have shown a low incidence of facet disorder with discogenic pain.44

The onset of pain is generally gradual and insidious. Patients generally are not able to relate a specific event or determine a specific date of onset. The exception to this rule is a forceful fall in which the individual lands on the buttocks. We have observed graphic instances of this in cases of occupational injury (for example, with one leg dropping into a manhole not protected by a cover and the pelvis striking the ground). These cases may initially be treated as back sprains or back contusions, only to present years later with typical syndrome of internal disc disruption. Although direct loading injuries to the lumbar spine can explain the onset of internal disc disruption biomechanically, victims of motor vehicle accidents in whom this disorder is diagnosed have had a preexisting problem that is only aggravated by the accident. Loading injuries do not occur even in high-velocity accidents with the individual in the seated position.

CAUSATIVE FACTORS

Unquestionably, repetitive or continuous axial overloading is the key determinant in the pathogenesis of lumbar disc degenerative disease. Morbid obesity continues to be a major public health issue in the United States and, to a lesser extent, in other Western nations. The clinical triad in the obese individual is intractable low-back pain, bilateral knee pain, and flat feet with bilateral ankle pain. The primary pathological process is cartilaginous degeneration in the intervertebral discs and the cartilage in the knee joint. Although axial loading is the obvious factor implicated, accelerated degeneration due to fatty infiltration of cartilage may not be ruled out. It is unwise in this setting to consider surgical intervention until serious measures are undertaken for weight reduction. These may include sustained, systematic reduction in caloric intake under medical supervision, increased physical activity with a tailored exercise program, pharmacological therapy for appetite suppression and enhanced fat excretion, and, as a final resort, gastric bypass surgery. If the patient fails to participate in a weight-reduction program, it will be futile in most instances to consider back surgery.

Genetic factors have an influence in the incidence of the DDD.3 Defects in the DNA for collagen have been identified in family clusters predisposed to degenerative disc disease. Other genetic defects resulting in impaired proteoglycan synthesis are being explored. Videman, et al.46 noted that polymorphism associated with the vitamin D receptor gene correlated with intervertebral disc degeneration. Richardson, et al.41 confirmed, through an epidemiological survey, the presence of a familial disposition for back pain. Degenerative disorders involving family clusters tend to manifest as multilevel disc herniations at a younger age. Elfering, et al.14 noted a high incidence of disc degeneration in individuals working night shifts because of the relative dessication of the disc at night. Occupation is a very important determinant. Workers performing typical repetitive work in an assembly line setting are prone to back problems, especially if the work involves repetitive bending, turning, and lifting. Jobs necessitating lifting and carrying heavy loads are associated with a high incidence of lumbar degenerative disease; examples include furniture movers, landcareers, and medical assistants working in nursing homes. Authors of epidemiological studies point to whole-body vibratory forces such as driving trucks, earthmovers, or tractors as contributing to low-back pain.18,40

Vigorous and compulsive athletic activities in a competitive setting predispose to accelerated degeneration of discs.3 Examples include weightlifting and gymnastics.

Cigarette smoking is implicated in DDD, but a direct link has not been proven.

PAIN GENERATION

It is crucial to understand and localize the DDD-related pain generator to tailor the surgical treatment and eliminate the source of pain. As stated previously, O’Brien55,36 has noted pain in the anterior anulus on direct palpation of the area transabdominally. In pioneering studies in performing lumbar laminectomy after injection of a local anesthetic Kuslich, et al.,23 and others49 noted that anular fibrosis is the most pain-sensitive structure. Histopathological studies of cadaveric discs and those removed surgically have shown rich innervation of the anulus. The nerve terminals involved may be either somatic or autonomic.19,37,45 It is intriguing to observe that in the pathological disc there is more active sprouting of the nerve terminals than in a normal disc.10 Ashton and associates2 identified substance P in the vascular endothelium of the anulus fibrosus in excised discs. All of these observations indicate that total disc excision to eliminate all anular pain nerve endings should be part of a well-designed surgical procedure. This observation is also corroborated by the fact that patients who have undergone nondiscectomy posterior spinal fusion may continue to experience discogenic back pain despite demonstration of solid posterior fusion on neuroimaging studies. An ideal operation should eliminate the disc (the pain source) as well as motion.

MAGNETIC RESONANCE IMAGING FINDINGS

There are certain consistent MR imaging changes indicative of DDD.15,17,29,38,39 but the findings should always be interpreted in light of clinical presentation because it is impossible to differentiate symptomatic from incidental syndromes based on MR imaging studies alone.32 A defining characteristic is the decrease in signal intensity on T1-weighted sequences obtained in the nucleus pulposus compared with the adjacent disc (Fig. 1). The outline of the nucleus pulposus becomes irregular and the disc height decreases. An intense dotlike high-intensity signal in the posterior anulus signifies an anular tear.43 The cortical endplate and the adjacent marrow show changes in three steps, well described by Modic.31
Black disc disease

Fig. 1. Sagittal $T_2$-weighted MR image demonstrating black disc disease at L5–S1.

ROLE OF DISCOGRAPHY

Although the role of provocative discography in the diagnosis of discogenic pain syndrome remains controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controversial, in the past 2 to 3 years its role has become better defined.1,4,9,28,33,47 The results are still somewhat controvers

PATIENT MANAGEMENT

As a sound surgical principle, general conservative measures should be instituted first. These may include a long-term exercise program for conditioning, physical therapy with various modalities, a trial of epidural steroid injections, and a corset worn only when the patient is active. All of these physical measures are supplemented by pharmacological therapy involving nonsteroidal anti-inflammatory drugs, muscle relaxers, and low-potency narcotic agents. A patient’s lifestyle or vocation may have to be modified to avoid repetitive injury. Restrictions at the worksite and establishment of an ergonomic environment in the workplace, with the assistance of an occupational therapist, might help reduce the likelihood of repetitive injury.

Failure of conservative treatment over a period of 3 to 6 months heralds the need for surgical treatment. Table 1 provides a summary of the surgical choices available today. The number of choices is increasing with the introduction of percutaneous placement of pedicle screws and the impending approval of bone morphogenetic protein for clinical use. The choice of surgical procedure is also governed by published results pertaining to long-term follow-up in patients who have undergone surgery via various techniques.

Cloward8 pioneered the technique of PLIF in which structural allograft was used. Although he reported 80 to 90% fusion rates without the use of pedicle screws, others6 have not been able to reproduce his success rate. Lin25 and Ma27 have refined the PLIF technique. Poor success rates have led to other techniques. Kuslich, et al.,22 introduced the use of threaded cages, but analysis of recent results indicates that there is high failure rate with stand-alone cages introduced anteriorly or posteriorly, unless they are supplemented by pedicle screw stabilization. Anterior interbody fusion with femoral ring in single-level disease yields a success rate of 80 to 90%, but the rate drops precipitously in two-level procedures unless supplemented by posterior stabilization. The Harrms transfemoral fixation technique41 involves the unilateral removal of facet joint, radical discectomy, anterior column support in which cages are supplemented by bone, and pedicle screw stabilization. This is a viable alternative to combined 360° decompression and fusion and is currently our preferred option for black disc disease. The choice of surgical technique16,20,21,24,26,32,34,48,50,51 is left to the surgeon as long as the following principles are adhered to: near-total excision of the intervertebral disc; placement of spacer to maintain anterior column support and lordosis; use of adequate bone graft, bone extender, and bone enhancers; and surgical stabilization.

TABLE 1

Surgical options in black disc disease*

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<th>Procedure</th>
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<tr>
<td>ALIF alone</td>
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<td>ALIF w/ transfacetal screw</td>
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<td>ALIF w/ pedicle screw stabilization (open or percutaneous)</td>
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<td>PLIF w/ pedicle screw stabilization</td>
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<td>Transforaminal interbody fusion with pedicle screw stabilization</td>
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* ALIF = anterior lumbar interbody fusion.

References

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