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The Proper Terminology for Reporting Lumbar Intervertebral Disk Disorders

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Nature enjoys making fun of our classifications.
Pierre Masson (1880–1959)

Despite these somewhat disheartening words from the famous French pathologist, we should not give up solving the present mess associated with the reporting of intervertebral disk abnormalities in imaging studies. The present variations in the usage of language are responsible for confusion and controversy, and also compromise our chances of reaching a consensus on the diagnosis and treatment of disk disorders (1–5). As in other areas of medicine (eg, the TNM classification of tumors), it should be possible for diagnostic radiologists to rally round a uniform nomenclature. Why has it been impossible so far? The historical lack of interest among traditional physicians, fundamental anatomists, and imaging specialists for the deemed trivial and vulgar issue of low back pain probably has something to do with it. Controversies regarding treatment, especially surgical indications, as well as legal and socioeconomic considerations, have also colored many debates. Over the last 10 years, several articles have dealt with the nomenclature of disk disorders in relation to the interpretation of imaging studies (6–16), but none of the proposed schemes has so far succeeded in generating universal acceptance.

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In 1981, the American Academy of Orthopedic Surgeons published the *Glossary on Spinal Terminology* (17). In this work, the term *herniated nucleus pulposus* (considered synonymous with *intervertebral disk rupture*) was defined as "displacement of nuclear material and other disk components beyond the normal confines of the annulus." Five categories of displacement were recognized: intraspongy nuclear herniation (Schmorl's nodes), protrusion, incomplete herniation, extrusion, and sequestration. The definitions provided for some categories were ambiguous and more suitable for surgeons and pathologists than for radiologists reporting imaging studies. Some of the terms proposed in this nomenclature are still being used today, but with different definitions, which only add to the confusion. National and international radiologic societies have abstained thus far from dealing with this issue. In their approach to disk disorders, radiologists do not constitute a homogeneous group: the concepts of those who use diskography and interact daily with physiatrists and orthopedic surgeons are different from those of neuroradiologists who interact with neurologists and neurosurgeons (18).

The nomenclature to describe disk lesions has been greatly influenced by two factors: our concept of disk degeneration throughout life and our understanding of the physiopathology of clinically relevant disk disorders. Regarding the lumbar disk, our perception of what constitutes the normal aging process has been tailored by postmortem anatomic studies involving a small number of lumbar spine specimens, taken from persons from different age groups of whom very little was known, and who were simply presumed not to have suffered from disk disease (19–24). These studies did not lead to uniform conclusions. Eckert and Decker (20) noted that, with increasing age, there was swelling and hyalinization of the lamellae of the annulus fibrosus and that the nucleus pulposus showed the greatest changes, with a progressive increase in fibrous character and decrease in mucoid stroma. However, these authors did not observe radial fissures of the annulus or protrusions of the nucleus. Performing diskography on postmortem specimens, Kieffer et al (22) reported similar findings, but also found radial annular tears in 35% of disks removed from patients over 40 years old and concluded that disk rupture occurs frequently without signs and symptoms of nerve root compression. Although Kieffer et al did not conclude that annular radial tears were part of the normal aging process, this was the impression Bates and Ruggieri were left with, since they wrote, referring to this particular study, that radial tears were likely to be an incidental finding in the aging process (25). The series of cadavers investigated by Coventry et al (19) showed more severe changes, which lead these investigators to conclude that intervertebral disks retrogressed more rapidly and severely than most other tissues. These authors hypothesized that the constant use of intervertebral disks, as well as their susceptibility to trauma and their poor blood supply, doomed them to early and advanced degenerative changes. The confusion about the features of normal aging persists, as there are those who believe that the MR signal characteristics of disks allow one to differentiate the normal aging process from pathologic degeneration (26) and those who think that this distinction is not possible (27) or that pathologic disk degeneration may just represent an acceleration of the normal aging process (12). The nomenclature one favors is directly related to one's physiopathologic model. Radiologists of my generation have been taught that, as a result of sudden or chronic trauma, the incompressible nucleus can protrude through its fibrous wall (28); and should this occur in a posterior or posterolateral location and encroach on the neural canal, cord or nerve root pressure may result, with consequent segmental root pain and muscle spasm (29). The emphasis on developing imaging strategies that focus on the demonstration of lumbar disk herniations associated with nerve root compression is obvious in many of the articles published over the last 20 years (30–39), although the importance of associated congenital or acquired bone spinal stenosis has recently been recognized (40–45).

Under the influence of these two factors, a simple terminology requiring no effort to distinguish the normal aging process from pathologic degeneration was developed in the 1980s for the interpretation of myelograms and high-resolution CT scans: one needed only to choose among the normal disk, the bulging disk without nerve root compression, and the herniated disk with nerve root compression (33, 46). The validity of this model has been challenged in recent years, as it now appears that radicular pain is caused by inflammation of a nerve root, not by compression per se (47). This relatively new concept has led to the development of a new nomenclature, applicable to the interpretation of both MR and CT studies, that avoids most controversies and is based on an assessment of the disk contour without reference to nerve root compression (16). In this scheme, disks are classified as normal, bulge, protrusion, and extrusion (Fig 1) according to their shape, and more specifically the observed "disk extension beyond the interspace" (DEBIT). Further simplification of this terminology, in which the term *herniation* would be used to designate, collectively, protrusions and extrusions, has been suggested (12), but Brant-Zawadzki et al (16) suggest maintaining this distinction, because extrusions are rare in asymptomatic patients, as opposed to bulges and protrusions. Furthermore, these authors argue that the term *herniation* may be problematic by having too many ambiguous histologic implications, as well as a traumatic connotation, with a suggestion of inevitable clinical significance. Deyo et al (48) believe that physicians should be wary of labeling patients with frightening diagnoses, and that the term *ruptured disk*, for instance, implies a bursting or violent dissolution of tissue while the term *extruded disk* is less emotionally laden.

This terminology has the advantage of being simple. However, the assessment of the disk contour on axial CT or MR sections is not easy, and studies have shown that this particular terminology generates only moderate interobserver agreement, even when used by experienced neuroradiologists (16, 49). As an example, differentiating an extrusion from a protrusion may be difficult when dealing

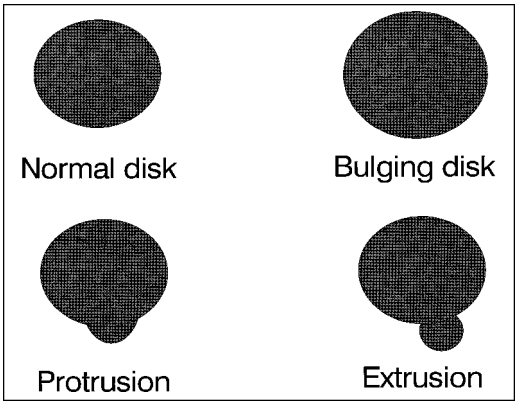

Fig 1. Schematic representation of a morphological nomenclature based on a two-dimensional assessment of the disk contour. *Normal disk:* absence of disk extension beyond the interspace (DEBIT). *Bulging disk:* circumferential, symmetric DEBIT (around the endplates). *Protrusion:* focal or asymmetric DEBIT; the base against the parent disk is broader than any other diameter of the protrusion. *Extrusion:* focal, obvious DEBIT; the base against the parent disk is narrower than the diameter of the extruded material itself, or there is no connection with the parent disk.

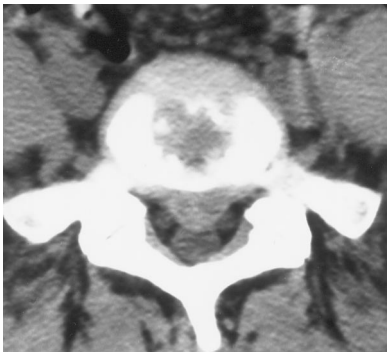

Fig 2. Axial CT section through L5-S1 shows rather large posterior central displacement of disk material, with slight dural sac compression. According to the definition, this displacement should qualify as a protrusion. However many observers will be inclined to use the word *extrusion* because of its large size.

with a narrow spinal canal, a foraminal herniation, or even a large central herniation (Fig 2). Initially conceived for the interpretation of axial CT sections, this classification considers the disk as a two-dimensional homogeneous structure and does not take into account intrinsic loss of the disk's integrity or alterations of the adjacent vertebral bodies. Modic and coworkers (50, 51) have documented, on MR images, vertebral body marrow changes associated with degenerative disk disease (types 1, 2, and 3). I believe such findings should be reported, because they represent clinically relevant information. Types 2 and 3 indicate a chronic process, whereas type 1 represents objective confirmation of an acute or subacute inflammatory disorder that may explain pain. Modifications of the MR disk signal—usually a decreased signal intensity on T2-weighted images—is a reliable indicator of physicochemical alterations that may be clinically relevant, and should also be reported; this nomenclature should therefore be expanded to provide a classification for disks with normal contour but abnormal signal intensity. The major problem with this nomenclature resides in the fact that it creates artificial pathologic entities. The bulging disk is defined as a disk that extends diffusely beyond the adjacent vertebral body margins in all directions, but its exact anatomic or pathologic nature remains a subject of great controversy. Yu et al (52), using cryomicrotome postmortem anatomic studies, found complete radial annular tears in most bulging disks, thus correcting the impression derived from earlier postmortem studies (45) that, even in young persons, a disk with an intact annulus may exhibit a detectable bulge on axial CT sections. A more recent hypothesis has been raised that bulging disks occur as a result of tears in the collagen bridges between the concentric annular fibers, thus producing diffuse laxity of the annulus while concentric annular fibers themselves remain intact (12). However, while studying the structure of the lumbar annulus fibrosus using a layer-by-layer peeling technique and microscopic examination of various cut surfaces, Marchand and Ahmed (53) found no sign of the presence of any such layer-to-layer connections or links. It is important to realize that the appearance of a diffuse "circumferential" disk bulging on a CT or MR axial section constitutes a visual finding requiring the elaboration of a differential diagnosis (Table 1). A bulging disk is not a pathologic entity, and I agree with Nachemson (54) that this term should not be offered as a diagnosis in radiologic reports.

TABLE 1: Differential diagnosis of a bulging disk on CT or MR axial sections

1. Normal anatomic variant
2. Illusion caused by volume-averaging effect
3. Normal aging disk remodeling related to vertebral body osteoporosis
4. Pathologic disk degeneration (deteriorated collapsed disk)
5. Posterior disk rupture with subligamentous herniation

Another nomenclature model, based on expected anatomy and pathology, has been proposed as a result of the development of two concepts (9). The first concept is that the normal aging process can indeed be differentiated from true pathologic degeneration. Resnick and Niwayama (55) have emphasized that the intervertebral disk can be affected by two different degenerative processes, one affecting the annulus fibrosus ("spondylosis deformans") and the other affecting the nucleus pulposus ("intervertebral osteochondrosis"). Data from other sources suggest that what is referred to as "spondylosis deformans" is nothing more than the normal aging process while "intervertebral osteochondrosis" corresponds to real pathologic deterioration and collapse of the disk, associated with bone erosion and reactive osteosclerosis (56–59). What we have learned so far about the normal aging process and the pathologic deterioration of a disk has been well summarized by Herzog (60). It appears, from pathologic studies and experimental animal models, that the

formation of a complete radial annular tear is the necessary condition for the progressive deterioration of a disk. Herzog suggests that this state of biomechanical disk failure be referred to as advanced disk disruption and degeneration to distinguish it from an aging disk that has not failed. The second concept that has inspired the development of the terminology I am about to present is that annular tears need to be diagnosed because they can cause low back pain and referred pain in the absence of modification of the disk contour. There is more and more evidence that "diskogenic pain" really exists, and that a disk rupture may cause radiating pain to an extremity in the absence of any direct contact between extruding disk material and a nerve root (61–64). Such pain may result from radial annular tears reaching the pain-sensitive external part of the annulus fibrosus. The advent of MR imaging has stimulated renewed interest in anatomic studies of the intervertebral disk and spinal ligaments (65–74). Postmortem studies have shown that MR imaging is a specific and sensitive method for detecting abnormal biochemical disk changes that precede structural changes (75). Diskography remains more sensitive than MR imaging for detecting radial annular tears (76) but these tears often cause a detectable decrease in signal intensity on T2-weighted MR images, sometimes associated with a peripheral focus of high signal intensity (77, 78). These tears may also enhance after intravenous injection of a paramagnetic contrast agent (79).

The particular nomenclature I am referring to considers the disk as a three-dimensional structure and is based on the expected anatomy and pathology of both the disk and adjacent vertebral bodies: disks are classified in the categories of a normal young disk, a normal aging disk, a scarred disk, an annular tear, and a herniated disk (Fig 3). This scheme can be applied to all imaging techniques, including plain films, and can be supplemented with the Dallas diskogram description (80) if CT diskography is being performed. In the case of plain CT, a pilot study free from superimposed reference lines can serve as an acceptable substitute to plain films for an assessment of the intervertebral space height. Diskography is not mandatory to diagnose annular tears, since a definite loss of central disk signal intensity, on T2-weighted MR images, is accepted as evidence of the presence of a major tear involving the outer annulus. The categories are not mutually exclusive, and all possible situations are covered. Mastering this nomenclature requires some time and effort, because assessment of multiple parameters is required to differentiate normal aging disks from truly degenerated or "scarred" disks (Table 2). The choice of the term *scarred disk* to designate pathologic degeneration and collapse was made with the histopathology in mind and with the intention of avoiding the ambiguity of the term *degenerated disk*. Unfortunately, this term can be misinterpreted as referring to postoperative changes. The term *chronic diskopathy* would probably constitute an acceptable alternative, although the term *deteriorated disk* would be my personal choice. Finally, the reliability of this nomenclature has never been tested: intraobserver and interobserver

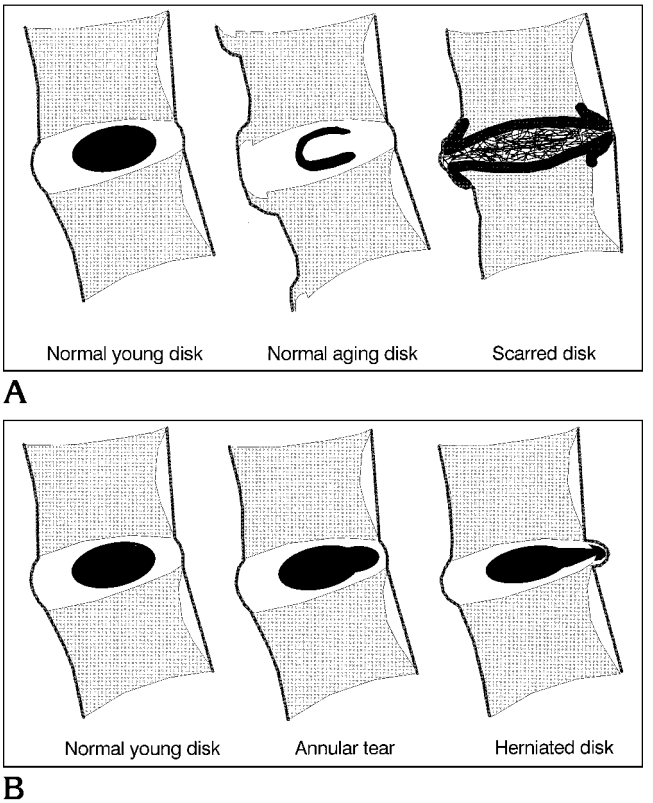

Fig 3. Schematic representation of a nomenclature based on a three-dimensional assessment of the anatomic and pathologic characteristics of both disk and adjacent vertebral bodies. The term *scarred disk* is meant to indicate chronic disk degeneration, deterioration, and collapse unrelated to previous surgery. The differentiating features between the *scarred disk* and the *normal aging disk* are indicated in Table 2. In this terminology, herniated disk is defined as a "focal displacement of disk material beyond the normal peripheral margin of the intervertebral disk space, corresponding to the original margins of the adjacent vertebral body endplates." Disk herniations are then further qualified according to the size and location of the displaced disk material.

variations in differentiating discrete herniations from pure annular tears are to be expected.

Regardless of which of the nomenclatures I have discussed one uses, the size and location of the disk material that is focally displaced beyond the normal peripheral margin of the intervertebral disk space also need to be specified in imaging reports. Although it is common practice, qualifying herniations (or protrusions/extrusions) as small, medium, or large is unreliable, because the size of the spinal canal is not considered. A simple scheme consists in roughly dividing the cross-sectional area of the spinal canal into thirds (anterior, middle, posterior) and in describing the displaced material accordingly. To specify its location in the spinal canal, I like the division into zones favored by the Nomenclature Committee of the North American Spine Society. These are, for the sagittal plane: diskal, suprapedicular, pedicular, and infrapedicular; for the horizontal plane: central, subarticular, foraminal, extraforaminal, and anterior. The demarcation between the

TABLE 2: Differentiating features of the normal aging disk and the scarred disk

Criterion	Normal Aging Disk	Scarred Disk
Clinical		
Age	Over 40 y	All ages
Symptoms	None	Frequent
History of low back pain	None	Frequent
Plain films and CT		
Disk space height	Normal	Decreased
Posterior disk margin	Regular	Irregular
Vertebral bodies	Normal	Osteosclerosis
Osteophytes	Anterolateral	All directions
Intradiskal gas	Anterolateral	Central
Number of affected disks	All	Variable
Additional criteria for MR		
Vertebral body marrow	Normal for age group	Type 2 or 3 changes*
Central disk signal intensity	Slight decrease	Marked decrease

* Classification proposed by Modic et al (50).

TABLE 3: Classification based on a clinical staging of lumbar diskopathy*

1. Low back pain ± radiating pain. No objective sign.
2. Low back pain ± radiating pain. Segmental pain, muscle spasm, and/or motion restriction.
3. Low back pain ± radiating pain. Signs of dural or radicular irritation.
4. Low back pain ± radiating pain. Neurologic deficit.

* *Diskopathy* is intended to mean any noninfectious or nonneoplastic disk lesion (annular tear, herniated disk, deteriorated disk); changes related to the normal aging process are excluded.

central and subarticular zone corresponds to the medial edge of the facets; the demarcation between the extraforaminal and anterior zone corresponds to the midcoronal plane of the vertebral body. For the foramina, a rough division between upper and lower parts is probably adequate. To report the separation of a disk fragment from the parent disk, the term *disk fragment migration* is less confusing than the term *sequestered disk,* which has a different meaning to a surgeon than to a diskographer contemplating chemonucleolysis. Additional comments about the integrity of the posterior longitudinal ligament, or about the location of the displaced disk material with respect to this ligament, can be added cautiously by those who are familiar with the modern anatomic concepts developed by Schellinger et al (69). With all these issues in mind, Bonneville (8, 10) has suggested an appealing five-point morphological classification of disk herniations, using letters, numbers, and signs, that may facilitate its international acceptance and statistical use. Finally, the term *intravertebral disk herniation* can still be applied to the special situation of cartilaginous (Schmorl's) nodes (81).

The required terminology to describe the size and location of displaced disk material is likely to be less controversial than the more fundamental issue discussed previously, namely: Which basic nomenclature should we adopt: one based on observed morphology of the disk contour or one based on predicted anatomy and pathology? Attempts to straddle both schemes are doomed to failure. Trying to differentiate a herniated disk from a bulging disk is like trying to differentiate a truck from a motor vehicle. This problem has no solution because these two entities are not mutually exclusive and the terms refer to classifications established on a different basis: it should be obvious from Figure 3B that a posterior central subligamentous disk herniation, especially if associated with disk space narrowing and buckling of the anterior annulus, is one of the causes of a bulging disk appearance. An acceptable nomenclature should of course be useful for those reporting imaging studies, but it should also aim at conformity with macroscopic anatomy and pathology. This is essential to allow correlation with surgical and postmortem findings, which still constitutes the standard of reference for imaging specialists for the validation of any nomenclature. This is why I personally favor a nomenclature based on expected anatomy and pathology. I also think that we can and should distinguish changes resulting from the normal aging process from those caused by pathologic degeneration.

Ideally, the nomenclature used for imaging should also correspond to clinical entities and orient the referring physician as to treatment. Unfortunately, we will probably have to give up on that in the case of disk disorders. Abnormal findings have been reported by radiologists in asymptomatic subjects on plain radiographs (82–84), myelograms (85), diskograms (86, 87), CT scans (88), and MR images (89–93). Although the subjects in these published series all denied a history of significant low back pain, the lack of recall regarding low back pain has been well documented (94), and these studies do not allow us to conclude that the reported imaging abnormalities are part of the normal aging process. Nevertheless, they clearly support the notion that one must be careful before attributing causality to any abnormal finding in a symptomatic patient (95–97). Having acknowledged this problem, we must never forget that back pain is not an anatomic lesion but a symptom that primary care physicians have to deal with, very often long before a patient sees a surgeon (98).

Cases for which there is no surgical indication must often be evaluated by insurance companies or workers' compensation agencies, which presently have to cope with the ambiguities of our imaging reports. For the purpose of compensation, a nomenclature based on clinical rather than imaging findings would probably be the best solution (Table 3). The main objective of imaging studies, in that particular context, would be to support the clinical diagnosis by showing objective evidence of any kind of diskopathy (ie, annular tear, herniation, deteriorated disk) in a location consistent with the clinical findings. With such a scheme, the often discussed problem of interobserver agreement relative to the interpretation of imaging studies (16, 49, 99–102) would be curtailed, since an evaluation of whole-person impairment percentages would not generate litigation over the assessment of the disk contour to ascertain whether a "herniation of the nucleus pulposus" exists.

No individual can hope to achieve nomenclature standardization. I have tried to take stock of the present situation and provide a few practical guidelines for the daily reporting of imaging studies while we await some official consensus emanating from national or international societies. Let us hope this is not too far down the road.

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