UPDATE IN RADIOLOGY

Standardized terminology for disc disease

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Abstract This article reviews the terminology used to describe morphological alterations in the intervertebral discs. Radiologists must be able to communicate information about the type, location, and severity of these alterations to medical and surgical clinicians. It is crucial to use simple, standard, and unified terminology to ensure comprehension not only among radiologists but also with professionals from the different specialties for whom the radiology reports are written (fundamentally traumatologists and neurosurgeons). This terminology will help to ensure a more accurate diagnosis and better patient management.

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PALABRAS CLAVE
Nomenclatura; Disco intervertebral; Hernia; Protrusión

Resumen El objetivo de este artículo es revisar la terminología que describe las alteraciones morfológicas del disco intervertebral para lograr unificar entre radiólogos y especialistas médico-quirúrgicos el tipo, la localización y la gravedad de dichas alteraciones. Es crucial emplear una terminología simplificada, estandarizada y unificada, para que exista un adecuado entendimiento no solamente entre los especialistas en Radiodiagnóstico, sino también con las distintas especialidades a las que van dirigidos los informes radiológicos (Traumatología y Neurcirugía fundamentalmente). Esta terminología ayudará a hacer un diagnóstico más preciso y a un mejor manejo del paciente.

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Introduction

The existing terminology on disc pathology is confusing and inconsistent in the literature, not only among the different medical and surgical specialties but also among radiologists themselves. Most neurosurgeons and orthopedic surgeons are beginning to use a more standardized nomenclature that helps distinguish lesions most likely to be clinically relevant from those that are not.1–3 Many authors of benchmark publications (Fardon, Milette and Modic, among others) differ in the terminology used in their reports; there is therefore the need (and even the plead) to achieve certain uniformity,4–6 since the lack of uniformity affects patients, who are sometimes victims of inadequate or insufficient treatment. We aim to review the terminology that describes the morphological abnormalities of the discs in order to unify
the description of the type, location and severity of disc abnormalities among radiologists and medical-surgical specialists.

The role of the radiologist in disc pathology

The radiologist must provide exact morphological information, thus helping in the diagnosis and in the decision making process. Given that to date there is no correlation between imaging findings, presence of symptoms and prognosis, the information provided by the radiologist should be as reliable as possible.

It is advisable to standardize the report with regards to the location of lesions and simplify the anatomic descriptions of the computerized tomography (CT) and magnetic resonance (MR) findings. In order to achieve standardization, the definitions should be based upon the anatomy and pathology and not upon the etiology, symptoms or imply need for specific treatment. In addition, the terms should be close to daily clinical practice.6

In order to evaluate an MR of the spine, the following parameters must be taken into account: signal, height and morphology of discs (contour abnormalities or displacements), integrity of the vertebral endplates, height and signal of the vertebral body, status of the posterior longitudinal ligament, size of the neural foramen and the lateral recess (in axial and sagittal planes), integrity and status of the facet joints, caliber of the spinal canal, signal of the spinal cord, and location of the conus medullaris and cauda equina.7

Historical precedents

In 2001, the North American Spine Society (NASS) initiated efforts to create a specific terminology to describe pathologic conditions of the lumbar discs. This task force was joined by radiologists from the American Society of Spine Radiology (ASSR) and the American Society of Neuroradiology (ASNR) resulting in a document that provides standardized nomenclature to ultimately improve the life of patients with disc pathology.6 This document was endorsed by the American Association of Neurosurgeons, the

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Classification of disc lesions.</th>
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<td>Normal</td>
<td>Morphologic variant</td>
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<tr>
<td>Congenital/developmental variant</td>
<td>Degenerative/traumatic</td>
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<tr>
<td>Inflammatory/infectious</td>
<td>Neoplastic</td>
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Congress of Neurosurgeons and the International Coding Committee of the American Academy of Orthopedic Surgeons.8 Today, this terminology is the most recommended for describing disc pathology, and it classifies disc lesions in different categories (Table 1).

Anatomy and physiology of the intervertebral disc

A normal disc resembles a biconvex lens due to the fibrous tissue present in the nucleus shaped like a central band. A disc is considered as a 360° circumference that can be divided into four quadrants (Fig. 1).

Out of the categories mentioned in Table 1, the degenerative/traumatic one will be discussed in the current article. Disc degeneration can be physiological (disc aging
with diffuse involvement of all discs, especially those at the lower lumbar spine secondary to mechanical causes) or not (disc degeneration involving three discs at the most and caused by accelerated desiccation, atrophy and fibrous transformation of the disc with serious changes in the endplate).\(^9\) Disc degenerative changes themselves include desiccation, fibrosis, narrowing of disc space or loss of disc height, diffuse disc protrusion over the vertebral body and mucoid degeneration.\(^6,10,11\) Degenerative disc disease leads to the loss of turgidity of the nucleus pulposus and a decrease in elasticity of the fibrous annulus, which in turn causes the disc to protrude or even to displace, and in order for this to happen annular or endplate disruption should occur. In the past, it was believed that an aging disc was more susceptible to injuries in the traumatic setting. However, a herniated disc can in itself cause degenerative changes.\(^9\)

Annular tears or fissures are separations between annular fibers, avulsion of the insertions from the endplates or true breaks that extend transversally, radially or concentrically depending on whether they are parallel or perpendicular to the collagen fibers that constitute the annulus fibrosus.\(^12-14\) Annular tears are important as far as they are pathological and precursors to disc herniations, however, there is no clear correlation between the need of treatment and the presence of symptoms.\(^13,15\) The most frequent cause of herniated disc is the radial annular tear due to repeated microtrauma. This radial tear accelerates the degenerative changes in the disc.

Figure 3  Schematic representation shows the difference between protrusion and extrusion in the sagittal plane. In protruded discs A is greater than B. In extruded discs D is greater than C.

Through these tears, the nucleus pulposus finds a way out from the disc space, normally in a posterior or posterolateral direction.\(^9\)

Nomenclature

Herniation is defined as a localized displacement of disc material beyond the limits of the intervertebral disc space. The disc space is delimited above and below by the vertebral bodies (superior and inferior endplates), and peripherally by the outer edges of the vertebral ring apophyses. Following a long list of terms used to define the displacement of disc material (either of the nucleus pulposus or the fibrous annulus), it was concluded that “herniation” was the one causing less confusion, and it is therefore the most commonly used term.\(^6\) It was suggested to use the term protrusion (because of the implications that the term herniation may have on the patients), but this term is reserved to describe a certain type of herniated discs. Almost all recent reviews highlight the difference between herniated disc and bulging disc.\(^13,14,16\) The difference lies in the quantity of displaced disc. Any displacement less than 50% of the disc or less than 180° of its circumference is called herniated, whereas if it exceeds these values it is called bulging disc. While sometimes used

Figure 4  Schematic representation of the types of herniations in the axial plane.

Figure 5  Schematic representation of the types of herniations in the sagittal plane.

Figure 6  Schematic representation of the location of herniations in the coronal plane.
as a general term in the way herniation is defined here, the use of the term protrusion is best reserved for subcategorization of herniations.

Due to age-related changes, the intervertebral disc ends up extending diffusely (less than 3 mm) beyond the edges of the disc space, as a consequence of the degenerative process itself, remodeling and ligamentous laxity. It is a physiological process, radiologically known as diffuse bulging of the annulus.⁹

Among herniations, the term focal protrusion is used when the maximum diameter of the displaced disc material is smaller than the disc measured in the same plane. In the sagittal plane, the measurement will be in a superior–inferior direction, and in the axial it will be transversal (Figs. 2 and 3).

Depending on the degree of disc involvement, focal protrusion occurs when the base of the displaced material is less than 25% (or less than 90°) of the circumference of the disc. In contrast, herniated discs with a base between 25% and 50% are broad-based protrusions (Fig. 4).

The term extrusion is used when the maximum diameter of the displaced disc material is greater than the distance between the edges of the base in the same plane (for example, if measured in the sagittal plane, a protrusion would

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**Figure 7**  Schematic representation of the types of herniations according to their location in the axial plane.

**Figure 8**  Magnetic resonance. Types of herniations according to their location. Prot.: Protrusion.
have a smaller cranio-caudal diameter than the disc space, whereas an extrusion would surpass the edges of the disc space). This term can also be used when the displaced disc fragment has a narrow neck and a wider extruded part in the axial plane (Figs. 2–4).

At the same time, extrusions can be classified as migrations or sequestrations. A sequestration occurs when there is no continuity between the disc material displaced and the parent disc, that is, there is a free disc fragment. It is important to describe the presence of sequestrations, since it may be a contraindication to minimally invasive surgery. A migration occurs when the disc fragment is displaced but maintains the continuity with the parent disc. Through imaging techniques it is sometimes very difficult to determine whether there exists continuity or not within the disc; for this reason some authors recommend using the term migration as a generic term to describe the displacement of disc material away from the site of extrusion, regardless of whether it is sequestrated or not.6

Disc displacements can also be classified according to the presence or absence of containment. If the fibrous annulus is intact the herniation will be contained, whereas if there is a tear of the fibrous annulus the herniation will be uncontained, that is, there is a

Figure 9  Sagittal T2-weighted and axial T1-weighted MRI. Anterior herniation (arrows).

Figure 10  Sagittal and axial T2-weighted MR images. Left foraminal and extraforaminal protrusions (arrows). A lineal hyperintense image can be observed on the left lateral margin of the disc that corresponds to a radial tear.
communication between the epidural space and the spinal canal. With the currently available imaging techniques contained protrusions cannot be distinguished from uncontained ones.

The relationship between the displaced fragment and the posterior longitudinal ligament can also be classified as subligamentous, transligamentous or extraligamentous. It is not always easy to anatomically separate the posterior longitudinal ligament from the fibrous annulus or the dura, given its closed relation. If this occurs and the fragment is below these structures it is called subcapsular.\textsuperscript{6,13,16}

Figure 11  Magnetic resonance. Left foraminal protrusion (arrows). (A) and (D) Sagittal T2-weighted image. (B) and (C) Axial T2-weighted image.

Figure 12  (A) and (B) Central, left paracentral and left foraminal extrusions (arrows). (C) Axial T2-weighted image and (D) Sagittal T2-weighted image of the lumbar spine. Left foraminal extrusion with caudal migration (arrows).
The radiological report

Once the anomaly is detected and characterized, it is important to determine its location within the three space planes. Some authors tried to create a simple and precise system of classification for herniated discs based on the location of the displaced fragment. Bonneville proposed in 1990 an alphanumeric classification system according to the location of the displaced fragment.\textsuperscript{17,18} Wiltse et al. proposed in 1997 a new classification based on anatomic boundaries, in both the axial and the sagittal plane.\textsuperscript{19,20} In 2001, the NASS published the document describing the location of lesions in the three planes. In the coronal and sagittal planes, the cranio-caudal extension is determined according to its relationship to the pedicle, and herniations are classified at suprapedicular level, pedicular level, infrapedicular level or at disc...

Figure 13  Sagittal and axial T2-weighted MR images. Paracentral and right foraminal extrusion (arrows).

Figure 14  Sagittal and axial T2-weighted MR images. L4-L5 extrusion with caudal migration and foraminal component (arrows).
level. In the axial plane, the articular facets, the borders of pedicles or the neural foramen establish the anatomic boundaries. Determining the exact location of a herniation is not always so simple. The various locations are defined as central or postcentral, subarticular or paracentral, foraminal, extraforaminal and anterior. Herniations can extend to various levels, not only in the axial plane but also in the sagittal and coronal planes.\textsuperscript{7,13,19,21} (Figs. 5–16).

In the radiological report it is important to describe if the space is compromised (either the space of the spinal canal or the foramen) by the herniated disc, and it is classified as mild, moderate or severe depending on whether the space

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**Figure 15** Sagittal T1 and T2-weighted MR images and axial T2-weighted images of the lumbar spine. Disc extrusion with caudal migration and possible sequestration (arrows).

**Figure 16** Sagittal T2-weighted MR image, axial T2-weighted gradient-echo and axial T1-weighted MR images of the cervical spine. Subligamentous central herniation, left paracentral and left foraminal (arrows).
compromised is less than one third, between one and two thirds or over two thirds, respectively.\textsuperscript{6}

It is very important to specify in the report what nerve root is involved, and to correlate this information with the clinical information in order to avoid unnecessary surgery or surgery at an incorrect level. Ninety per cent of herniated discs are central or subarticular and affect the recess, whereas only 4–5\% are foraminal or extraforaminal, thus affecting the root coming out from the neural foramen.\textsuperscript{9,14} This information is also very important for the clinician, since there can be confusion if only the disc level where the abnormality is located is mentioned and the nerve root involved is not explicitly indicated. For example, an L4 level can be caused by a central or subarticular herniation of the disc L3–L4 or by a foraminal or extraforaminal herniation L4–L5, and the treatment would be different.

Limitations

The fundamental problem with MR is its lack of specificity. In more than two thirds of patients with unilateral lumbarisciatica, the imaging diagnosis does not correlate with the symptoms,\textsuperscript{21} and many asymptomatic patients may show pathologic findings, but this does not make them candidates for surgery. It is therefore essential to correlate the imaging findings with the symptomatology. Only patients with symptomatic herniations are candidates for surgery.\textsuperscript{13} Moreover, the great inter- and intra-reader variability should be highlighted, which result in a moderate or low interobserver agreement, even for the most experienced readers\textsuperscript{12,22} and consequently the technique is not 100\% objective.

Conclusions

As stated along this article, in order to describe disc abnormalities and achieve maximum objectivity in our reports, it is essential to use reliable and reproducible terminology, that at the same time is standardized and unified with the one used by other specialists, so that there is a correct understanding between radiologists and clinicians. All radiologists must contribute to eliminate the existing confusion by avoiding equivocal and inadequate terms.

Authorship

1. Responsible for the integrity of the study: MSP, AGS.
2. Conception of the study: AGS.
3. Design of the study: MSP, AGS, ASM, PGG, DPB.
4. Acquisition of data: MSP, AGS, ASM.
5. Analysis and interpretation of data: MSP, AGS, ASM.
6. Statistical analysis: N/A.
7. Bibliographic search: MSP.
8. Drafting of the manuscript: MSP, AGS.
9. Critical review with intellectually relevant contributions: MSP, AGS, ASM, PGG, DPB.
10. Approval of the final version: MSP, AGS, ASM, PGG, DPB.

Conflict of interest

The authors declare not having any conflict of interest.

References

