Lumbar disk disease: Do we all speak the same language?

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Purpose

To let know the classification, nomenclature, concept’s definition and different subtypes of lumbar disk pathology according to consensus document of the Northamerican Society of Spine, Northamerican Society of Spinal Radiology, And American Society of Neuroradiology.

To indicate in those terms that make the greater controversy between the different medical specialities implied.

To promote the uniformity and consensus in the used terms to describe the lumbar disk pathology in our speciality.

To show some practical cases that can be used as examples in their application.
Methods and Materials

The Northamerican Society of Spine (NASS), the American Society of Spinal Radiology (ASSR) and the American Society of Neurorradiology (ASNR) worked in a common document in which they pretend to define each of the concepts of the more frequent lumbar disk pathology.

Actually many medical societies follow these recommendations; however, the lumbar disk pathology terminology is still today very diverse and is the object of debate, controversy and confusion between clinicians, anatomists and radiologists.

This fact not only has medical implications but socioeconomic and legal because is a high prevalence pathology in our environment, being low back pain one of the first causes of work leave in the developed countries.

In this paper we show, succinctly and illustrated the classification, nomenclature, concept definition and different subtypes of the different implied entities, making a special emphasis in the more frequent conceptual mistakes found in the literature.

For that we have revised what it is recollected in the document mentioned before and also in recent papers that treat this issue that has allow us to establish differences and parallelisms between the different definitions and concepts that are recollected in the following section.

We have compiled lumbar spine MR studies performed at our institution during the months of October and November 2011 to illustrate the different kinds of disk lesions.

Our studies have a sagital T1 and T2 Turbo Spin Echo (TSE), axial T1 Spin Echo and T2 Fast Field Echo (FFE) to the intervertebral spaces, as our usual protocol. The images were obtained in a 1'5 T Gyroscan Intera (Philips Holand) equipment using a Sinergy Spine coil (Philips).
Results

The main diagnostic categories in the lumbar disk pathology of non infectious origin are classified actually following **two models** very different between them, that approach it from different perspectives:

1. **Morphologic model**, in which the only parameter is the disk position regarding to the intervertebral space. It establishes as different categories; normal disk, bulging disk or protruding disk, protrusion and extrusion.

2. **Histopathological model**, in which there is no reference to the shape of the disk´s contour or to its displacement but it describes the histopathological changes of it establishing five diagnostic categories that are not excluding between them: normal disk, secondary changes to the aging process (deforming spondylitis), secondary disk degeneration to pathological process (intervertebral osteochondroses), fissure or annular tear, and disk herniation.

To use the **histopathological model** it is necessary to know very well the observable differences in the imaging studies between the histopathological changes secondary to aging and those secondary to disk pathology; that is why it´s use can be more complicated than the morphologic model.

In the other hand, to the date **there are no evidence about which of the two classifications is the best**. Some authors defend that the histopathological model offers an approach through the image to the real changes that the disk suffers without the limitation of only the description of its location as it is in the morphologic model.

**The main problem arise when we try to combine the elements of both models.** As an example, it is not possible trying to differentiate a bulging disk (morphologic model) from a disk herniation (histopathological model) because the first is the result of the disk´s normal aging process with the deterioration of it and certain degree of posterocentral herniation.

However this is not always this way. As an example it is possible to differentiate with an image a bulging disk (morphological model) from a radial tear without disk herniation (histopathological model), because the first usually is secondary to the second.

The Northamerican Society of Spine (NASS), and Neuroradiology (ASNR) and the American Society of Spinal Radiology (ASSR) established many years ago a lumbar disk **classification that integrate both models**.
In it they are established the following different diagnostic categories no mutually excluding, so it is possible different combinations between them:

- A) Normal intervertebral disk.
- B) Congenital or developmental disk alteration.
- C) Traumatic/degenerative disk pathology:

1. - Annular tear:
   - Radial.
   - Transversal.
   - Concentric.

2. - Degenerative:
   - Spondylosis deformans.
   - Intervertebral osteochondroses.

3. - Herniation:
   - Protrusion.
   - Extrusion.

- D) Infectious/Inflammatory.
- E) Neoplastic.
- F) Morphological variant of uncertain significance.

Although this classification refers to lumbar disk pathology, it is also valid for the findings in the intervertebral disks in the cervical and dorsal spine.

**DIAGNOSTIC CATEGORIES IN THE LUMBAR DISK PATHOLOGY:**

A) Normal intervertebral disk is the one that presents a normal morphology and signal intensity, independent from the clinical context that has motivated the study.

This last refers to that occasionally some patients present low back pain or radicular pain with the presence of normal disks in the morphological study.

We exclude the degenerative alterations, of development and the adaptive changes that, in some contexts (aging, scoliosis, spondylolisthesis) could be considered as normal.
B) The different **congenital or developmental disk alterations** include both the congenital abnormal disks and those that present morphological changes secondary to adaptation to abnormal growth of the spine (scoliosis, spondylolisthesis).

C) The **degenerative/traumatic disk pathology** includes the annular tears, the degenerative changes and the disk herniation.

1. Fissure or annular tear that consist of an interruption of the collagen fibers from the fibrous annulus. Its appearance does not imply necessarily a previous traumatism. They present a high prevalence, that increases with age and they usually present as a casual finding because they are usually asymptomatic. Normally they associate to a degenerative disk. It is advisable to keep the term of annular rupture, for those tears secondary to traumatic events with a violent separation of the fibrous annulus.

The **fissures or disk tears** can be:

- **Radial**: The most frequent. They mean an interruption of the fibrous annulus layers from the pulposus nucleus to the extern margin. They are not related to age. They are associated to loss of the chondroid matrix, disk impingement and instability, considering the critical factor of their origin the intervertebral osteochondroses. Fig. 1 on page 12

- **Tranverse**: Horizontal fissures that happen in the fibrous annulus margins next to the vertebral platform that cause defects in the union of the annulus to the edge of the vertebral end plate. Fig. 2 on page 12

- **Concentric**: They come from the separation of the layers of the fibrous annulus. Fig. 3 on page 12

Transverse and concentric are a very common finding in autopsy studies of individuals older than 60 years and they are considered typically caused by spondylosis deformans or disk aging.

2. Disk degeneration:

- **Spondylosis deformans** includes the secondary disk changes to normal aging process with substitution of the mucoid matrix of the pulposus nucleus for fibrous tissue preserving the disk height. In MR studies we appreciate small symmetric and regular disk protrusions with the occasional presence of a small amount of gas (placed in transverse fissures) and involvement of
the adjacent apophysis as anterior and lateral osteophytes. Fig. 4 on page 13

- **Intervertebral osteochondroses** is a secondary disk involvement to pathological process, no necessarily symptomatic, in which there is involvement of the pulposus nucleus, extent fissures of the fibrous annulus and atrophy with loss of the disk height. The disk contour presents irregularities and protrusions and it can exist an important gas amount in the central disk space. Frequently we appreciate involvement of the disk vertebral end plates with erosions and sclerosis and multidirectional osteophytes that compromise the space of the medullar canal and of the foramina. Fig. 5 on page 14

3. The term **disk hernia** and of all the subtypes it is the one that has more variability in its interpretation.

Conceptually is a displacement of the **disk material out of the limits of the intervertebral space** with exclusion of the displacements of the disk form one location to another within the intervertebral space. A disk hernia is not considered the development of connective tissue that comes with the bone growth of the apophysis and vertebral end plates secondary to osteoarthritis (osteophytes).

In this meaning, the term **disk hernia should not be considered a synonymous of**:

- **Herniated disk** that refers to a disk herniation through a fracture of the disk through the vertebral end plate or vertebral body. In this cases it would be convenient a thorough description of the fracture and its relationships with the disk to avoid misunderstandings with a true disk hernia.

- **Nucleus pulposus herniation**, that results from an incorrect term because normally the herniated disk material is composed from it and other components (nucleus, cartilage, fibrous tissue from the annulus, fragmented apophyseal bone).

- **Disk rupture**, that refers to a traumatic etiology with disk disruption.

The concepts included in the diagnosis of disk hernia are protrusion, extrusion, migrated disk hernia, sequestrum, intraspongious hernia or of Schmörl and retromarginal hernia or limbus vertebra.
• In **disk protrusion** there is a rupture of a part of the intern fibers of the annulus, and through the nucleus pulposus is herniated while the extern fibers remain intact. It implies a disk displacement of less than 180° of the circumference of the disk considering focal when the base is smaller than 25% of the circumference of the disk and a wide base if it is between 25 and 50% of it. Conceptually the distance between the edges of the protruded material in the sagital plane should not be greater than the distance between the disk edges of the disk that it comes from and the diameter of the protruded material in the axial plane should not be greater than the neck or the base of the protrusion. **Fig. 6** on page 15

• In the **extrusion**, the nucleus pulposus is herniated through a complete rupture of the fibrous annulus so it is only restrained by the posterior longitudinal ligament. The herniated segment is still joined to the original disk but it can also extend cranial or caudal. Conceptually the distance between the edges in a sagital plane is superior to the height of the original disk, or the extruded disk fragment presents at least one of its dimensions greater than the base. **Fig. 7** on page 16

In numerous occasions they refer exclusively disk hernia without the specification if it is a protrusion or an extrusion.

From a clinical point of view **it is important to differentiate between the two** of them because the extrusions usually are symptomatic with a smaller frequency than protrusions.

The **extruded material can migrate** to its position from the original disk and even it can separate from it, that leads to its classification in:

• **Migrated disk hernia** is that in which the extruded material migrates dorsal, cranial, or caudally from the original disk. This is a concept that exclusively refers to position of the extruded material and not to the continuity of it with the disk. **Fig. 8** on page 17 and **Fig. 9** on page 17

• **Sequestrum** is a disk extrusion in which the nuclear extruded material loss contact with the original nucleus pulposus that could migrate cranial or caudally regarding the original disk. **Fig. 10** on page 17

**Other kinds of disk herniation** are:

• **Intraspongiosus hernia or of Schmörl** is an herniation of the nucleus pulposus in the vertebral end plate that cause a bone defect in the vertebral end plate in which the disk introduces. **Fig. 11** on page 18
• The last the retromarginal hernia or **limbus vertebra** is a herniation of the nucleus pulposus between the vertebral end plate and the epiphyseal annulus. **Fig. 12** on page 18

• It should especially be mentioned the concept of **bulging disk or protruding disk**, which refers to a generalized extension of the disk (>50% of the circumference of it) out of the limits of the intervertebral space in a distance normally smaller than 3 mm. **Fig. 13** on page 19

**Other possible distinctions** used with a small frequency to describe a disk hernia are:

• **Restrained hernia** is that in which the more external region of the fibrous annulus is found distended but complete so there is no communication with the epidural space or with the spinal canal.

• **Not restrained hernia**, that in which the more external region of the fibrous annulus is not complete.

• The terms **sub ligament or subcapsular** refer to that the herniated material is covered by the longitudinal posterior ligament (LPL) and keeps a ventral position regarding to it.

• The terms **trans ligament or extra ligament** refer to that the herniated material cross the LPL in the first case and occupies a dorsal position to it in the second case. These classifications regarding to the position of the herniated material and the LPL are complicated in the practice because frequently we cannot distinguished the LPL from the fibrous annulus or the duramater. That is why their use is not frequent.

• The terms **communicating or not communicating** refer to the interruption of the disk’s periphery that permits that the injected fluid inside reach the spinal canal. These are terms used in the contest of therapeutical disk infiltrations.

• **Submembranous hernia** is that in which only the duramater covers the herniated material.

**Location of the disk hernias:**
Appart from the mentioned before, when we describe a disk hernia it is necessary to determine its location in the axial plane Fig. 14 on page 19 and Fig. 15 on page 20. For that the majority of the radiologists use anatomical references that allow different the following:

- Posterior central.
- Posterior lateral, of the lateral reces or sub articular area.
- Foraminal.
- Lateral or extra foraminal.
- Anterior.

Of all of them the first two are the most frequent (90%) and the used terminology cannot cause controversy in the radiological community.

The description of the location of the hernias in the sagital and coronal planes is less frequently used. The more accepted classification place them at the level of:

- Disk.
- Infra pedicular.
- Pedicular.
- Supra pedicular.

**Volume of the herniated material:**

Initially the American Society of Spine propose to classify the herniated material volume in mild, moderate, moderately severe, and severe according to the occupation in different degrees the medullary canal.

However this classification is difficult in the cases in which the medullary canal present an important reduction of its caliber, that makes unviable its imaginary division in four compartments.

That is why that generally is advised to classify the herniated volume establishing in 3 degrees relating to the involvement of the medullary canal:

- **mild**, if it affects at least 1/3 of it.
- **moderate**, between 1/3 and 2/3.
- **severe**, if it affects more than 2/3.

In the other hand, the herniated material is classified in focal, wide base or circumferential according to if the displacement of the disk in the axial plane is less than 25% of the disk’s circumference, between 25 and 50% or between 50-100% respectively. Fig. 16 on page 21
Secondary radicular involvement to disk herniation:

As an interesting information for the clinician it is necessary to describe the radicular involvement (displacement, compression) secondary to the herniation.

- In general terms when the disk hernia has a posterior central location or sub articular (as an example at the L1-L2 level) the nerve root more involved is the one that has the name of the vertebra placed in a more caudal position in that level (L2).

- If the disk hernia has a foraminal or extraforaminal location, the nerve root involved is the one that has the name of the more cranial vertebra in that level. That is why the foraminal and extraforaminal (less frequent) disk hernias usually simulate the symptoms of posterior central and sub articular (much more frequent) of the immediate superior level. Fig. 17 on page 22

Finally the initial classification also refers to the infectious/inflammatory involvement of the intervertebral disks (discitis), as well as the neoplastic (relating to the primary tumor and metastasic disease) including in the last place a subclassification called morphologic variants of uncertain significance for those process that affect the intervertebral disk that are not delimited in any of the previously mentioned subtypes.
Images for this section:

**Fig. 1:** Left: Illustrative diagram of a radial tear (in green). Interruption of the layers of the fibrous annulus from the nucleus pulposus to the extern margin. Right: T2 weighted turbo spin echo (TSE) sagital MR. Concentric (superior arrow) and radial (inferior arrow) tears.

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**Fig. 2:** Left: Illustrative diagram of a transverse tear (in green). Horizontal fissures that happen in the margins of the fibrous annulus next to the vertebral end plate that cause defects in the union of the annulus to the vertebral end plate. Right: T2 weighted turbo spin echo (TSE) sagital MR. Transverse tear with disk extrusion (arrow).

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**Fig. 3:** Left: Illustrative diagram of a concentric tear. Separation of the layers of the fibrous annulus (in green). Right: T2 weighted turbo spin echo (TSE) sagital MR. Transverse tear (vertical arrow) and a small concentric tear (horizontal arrow).

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Fig. 4: T2 weighted turbo spin echo (TSE) sagital MR. Spondylosis deformans of the lumbar spine with involvement form L3-S1. Decrease of the signal intensity with preserved height of the disks. Small symmetric and regular disk protrusions.

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**Fig. 5:** T2 weighted turbo spin echo (TSE) sagital MR. Intervertebral osteocondroses of the lumbar spine with involvement of L2-S1. Decrease of signal intensity of the intervertebral disks associated to a loss of height and irregularity of them associated to protrusions in their contour. Multidirectional osteophytes with an anterior predominance in the superior vertebral end plates of L3 and L4.

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**Fig. 6:** Left: Illustrative diagram of a disk protrusion in a sagittal image. Rupture of part the anterior fibers of the annulus (in red) through which the nucleus pulposus herniates (in green) with intact extern fibers. The distance between the edges of the protruded material in the sagittal plane could not be greater than the distance between the edges of the original disk. Center: Illustrative diagram of a disk protrusion axial plane. The diameter of the protruded material (red line) could not be greater than the neck or the base of the protrusion (black arrow). Right: T2 weighted turbo spin echo (TSE) sagittal MR. Disk protrusion (affected disk between the two black arrows).

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**Fig. 7:** Left: Illustrative diagram of the disk extrusion in a sagittal image. Rupture of part of the intern fibers of the annulus (in red) through which the nucleus pulposus (in green) herniates with extern fibers tear. The distance between the edges of the extruded material in the sagittal plane is superior to the distance between the edges of the original disk. Center: Illustrative diagram of disk extrusion in an axial plane. The extruded material diameter in the axial plane (red arrow) is greater than the neck or the base of the extrusion (black line). Right: T2 weighted turbo spin echo (TSE) sagittal MR with disk extrusion in the L5-S1 level.

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Fig. 8: Left: Illustrative diagram of disk extrusion caudally migrated. Right: T2 weighted turbo spin echo (TSE) sagital MR. Caudal migration of the disk extrusion (white arrow).

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Fig. 9: Left: Illustrative diagram of disk extrusion cranially migrated. Right: T2 weighted turbo spin echo (TSE) sagital MR. Cranial migration of the disk extrusion (white arrow).

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**Fig. 10:** Left: Illustrative diagram of a sequestrum. Disk extrusion in which the extruded nuclear material loss contact with the original nucleus pulposus and migrates caudally regarding the original disk. Right: T1 weighted MR after gadolinium administration. Caudally migrated disk sequestrum with the sequestered fragment located between the vertebral body of L5 and the longitudinal posterior ligament LPL (arrow heads). Peripheral enhancement after the administration of contrast.


**Fig. 11:** Left: Illustrative diagram that herniates or Schmörl node in which we appreciate a nucleus pulposus herniation in the inferior vertebral end plate of the superior vertebra that causes a bone defect in it. Center:T2 weighted turbo spin echo (TSE) sagital MR in which we appreciate a bone defect in the inferior vertebral end plate of L4 regarding with a Schmorl hernia. Right: T1 weighted turbo spin echo (TSE) axial MR, in which we appreciate an axial image of the mentioned bone defect.

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**Fig. 12:** Left: Illustrative diagram of a retromarginal hernia or limbus vertebra. Nucleus pulposus herniation between the vertebral end plate and the epiphyseal annulus. Right: T2 weighted turbo spin echo (TSE) sagital MR. Nucleus pulposus herniation between the anterior superior vertebral end plate of L3 and the epiphyseal annulus (limbus vertebra).

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**Fig. 13:** Left: T2 weighted turbo spin echo (TSE) sagital MR at the level of the bulging disk or protruding disk. Center: MR fast field echo (FFE) in an axial plane at the level of the bulging disk or protruding disk. Generalized extension of the disk (>50% of the circumference of it). Right: We indicate in red the contour of the superior vertebral end plate of the inferior vertebra, In green we indicate the protruding disk passing over the previous, generally, in a distance lower than 3 mm.

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Fig. 14: Possible locations of hernias in an axial plane. Posterior central: red, Posterior lateral, of the lateral recess or subarticular area: green, Foraminal: yellow, Lateral or extraforaminal: pink, Anterior: black.


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**Fig. 16:** Illustrative diagram of the disk hernia classification according to the disk displacement in the axial plane. Focal: less than 25% of the disk circumference. Wide base: between 25 and 50% of the disk circumference. Circumferential: between 50 and 100% of the disk circumference.

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Fig. 17: Illustrative diagram of the radicular involvement secondary to disk herniation. Sagital image of the lumbar spine. Generally speaking when the disk hernia has a posterior central location or sub articular (in the example in the level L1-L2) the more involved nerve root is the one with the name of the vertebra located in a more caudal position to that level (L2). If the disk hernia has a foraminal or extraforaminal location, the nerve root involved will have the name of the more cranial vertebra at that level (L2 as an example). That is why the foraminal and extraforaminal (less frequent) disk hernias used to simulate the symptoms of the posterior central and sub articular hernias (much more frequent) in a level immediately superior.

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Conclusion

Years ago the different northamerican medical societies (NASS, ASSR and ASNR) established an only classification for the lumbar disk pathology that integrated the existing morphological and histopathological models.

This classification, is to the date, the one that is more accepted in the medical community, and is mentioned in practically all the review articles more recently published.

However, the lumbar disk disease terminology continues to the date very confusing and is subject to debate, controversy and confusion between the clinicians, anatomists and radiologists.

To know and to apply this classification in our reports allow a greater uniformity of criteria between the different observers that assist the understanding between the radiological community and between this and the rest of specialities implied in the diagnosis and treatment of this pathology.
References

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