# Don't You Call Me Desiccated, J. Wellington Wimpy

MR imaging of the lumbar spine often reveals disks with lower than normal signal intensity in the nucleus pulposus without decreased disk height or abnormal contours of the annulus fibrosus. Characterizing these disks as "dehydrated," "desiccated," or "dark" suggests that they need only a little more water to functional normally. Without evidence of herniation, protrusion, extrusion, or bulging, these disks meet the criteria for a stage III degenerated disk in the grading scale of Pfirrmann et al.[1] Stage III is distinguished from stage I and II disks, which are normal disks, by consolidation of fibrous tissue in the nucleus pulposus, loss of annular-nuclear demarcation, and decreased T2 signal intensity in the nucleus pulposus.

The numerous studies in which diskography and MR imaging are correlated document the presence of a radial tear in dehydrated disks.[2] Diskography in these disks consistently shows leakage of contrast medium from the nucleus pulposus into the epidural space and elicits "concordant pain"—that is the patient's typical back or leg pain. These observations show that the diminished T2 signal intensity in the disk reflects the presence of a radial tear in the annulus fibrosus.

MR imaging may show the presence of a radial tear in these dehydrated disks.[3] The high-intensity zone or streak of higher signal intensity in the periphery of a dark disk corresponds to the radial tear. This sign reflects the presence of granulation tissue or liquid material in the radial tear. MR imaging has relatively poor sensitivity for the detection of the radial tear because many radial tears do not have sufficient tissue within them to produce the imaging sign.[4] Incidentally, the radial tear should be distinguished from concentric and transverse tears of the annulus fibrosus, 2 types of tears that have no role in the pathogenesis of disk degeneration but occur often in an adult population.[5] Radial tears may also be demonstrated as contrast enhancement in the disk.[6]

Chemically, dark disks differ from normal disks. They have reduced concentrations and altered structure of glycosaminoglycans, which explain the reduced water content in these disks.[7] Disks with normal glycosaminoglycans concentration lose water reversibly, due to diurnal variations, but do not undergo the irreversible loss of water that is implied by the term "dehydrated disk." The loss of T2 signal intensity occurs secondary to biochemical changes, specifically the loss of glycosaminoglycans.

Biomechanically, dark disks differ from normal disks.[8] The radial tear, disrupting fibers in all layers of the annulus fibrosus, changes the physical properties of the disk. Biomechanical studies show that dark disks have diminished stiffness, especially to axial rotatory torques. In biomechanical terms, the dark disk is a failed disk, responding abnormally to forces and torsions applied to it.

J. Wellington Wimpy, a comic strip character featured in the "Popeye" series, was intellectual, soft-spoken, and generally lacking in fortitude and determination.

DOI 10.3174/ajnr.A2259

Dehydrated disks may cause low back or radiating pain by multiple mechanisms without herniation of the nucleus pulposus or bulging of the annulus fibrosus. The ingrowth into the radial of granulation tissue containing blood vessels and nerve endings converts the intervertebral disk to an innervated structure.[9] If the nerve endings are nociceptors, pain may result from the application of forces and torques to the disk. Pain resulting from stimulation of nerve endings in the disk may cause pain that is felt as originating in the low back or pain referred to a lower extremity, simulating the radicular pain resulting from nerve root compression. Second, the biomechanical properties of the dark disk may be the cause of pain. Due to the reduced stiffness of a disk with a radial tear, daily activities may result in excessive motion between 2 vertebrae joined by the disk.[10] This motion may produce intermittent compression of a spinal nerve and/or put excessive strain on the anterior longitudinal ligaments and facet joint capsules. Third, the radial tear may allow leakage of liquid glycosaminoglycans solutions into the epidural space where they may cause inflammation and pain. Disks with reduced T2 signal intensity have the potential to produce pain.

Intervertebral disks that have diminished T2 signal intensity without evidence of disk collapse or herniation differ from normal disks not only in water content but also in gross morphology, biochemistry, and biomechanics. Disks demonstrating lowered signal intensity but no evidence of herniation or bulging, meet the criteria for stage III degenerated disks in the Pfirrmann system and have the potential to cause low back or leg pain. The term "early disk degeneration" better characterizes these disks than terms like "dehydration" or "desiccation."

## References


1. Pfirrmann CW, Metzdorf A, Zanetti M, et al. **Magnetic resonance classification of lumbar intervertebral disc degeneration.** *Spine* 2001;26:1873–78
2. O'Neill C, Kurgansky M, Kaiser J, et al. **Accuracy of MRI for diagnosis of discogenic pain.** *Pain Physician* 2008;11:311–26
3. Aprill C, Bogduk N. **High-intensity zone: a diagnostic sign of painful lumbar disc on magnetic resonance imaging.** *Br J Radiol* 1992;65:361–69
4. Yu SW, Haughton VM, Sether LA, et al **Comparison of MR and diskography in detecting radial tears of the anulus: a postmortem study.** *AJNR Am J Neuroradiol* 1989;10:1077–81
5. Yu S, Sether LA, Ho PS, et al. **Tears of the annulus fibrosus: correlation between MR and pathologic findings in cadavers.** *AJNR Am J Neuroradiol* 1988;9:367–70
6. Ross JS, Modic MT, and Masaryk TJ. **Tears of the anulus fibrosus: assessment with Gd-DTPA-enhanced MR imaging.** *AJNR Am J Neuroradiol* 1989;10:1251–54
7. Weidenbaum M, Foster RJ, Best BA, et al. **Correlating magnetic resonance imaging with the biochemical content of the normal human intervertebral disc.** *J Orthop Res* 1992;10:552–61
8. Schmidt TA, An HS, Lim TH, et al. **The stiffness of lumbar spinal motion segments with a high-intensity zone in the anulus fibrosus.** *Spine* 1998;23:2167–73
9. Goldie I. **Granulation tissue in the ruptured intervertebral disc**. *Acta Pathol Microbiol Scand* 1958;42:302–04
10. Haughton VM, Schmidt TA, Keele K, et al. **Flexibility of lumbar spinal motion segments correlated to type of tears in the annulus fibrosus**. *J Neurosurg* 2000; 92(1 suppl):81–86



V. Haughton
*Department of Radiology*
*Section of Neuroradiology*
*University of Wisconsin School of Medicine and Public Health*
*Madison, Wisconsin*