

Disc Pressure Measurements Prove That the Pressure on the Disc
is 11 Times Greater When the Patient is Erect:
Therefore, the FONAR Upright" MRI Is the **ONLY** Appropriate Technology For
Evaluating Low Back Pain and For Choosing the Best Surgical Repair
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Direct measurements of disc pressure ^(1,2) establish quantitatively that the forces on the recumbent intervertebral disc are only a fraction of what they are on the upright disc. Indeed, on the basis of these direct in vivo measurements of disc pressure it would appear that an examination of the patient lying down is not a relevant examination for the patient experiencing back pain when he is upright⁽³⁾. Indeed the data strongly suggests that the recumbent-only MRI carries the very real prospect of either grossly underestimating the patient's spinal pathology because the forces causing it have been removed, or not seeing the pathology at all for the same reason.

The data prove unequivocally that for the approximately 9,000,000 patients scanned annually in the MRI for upright back pain ⁽³⁾, the FONAR Upright" MRI examination is the relevant examination.

In 1999, H. J. Wilke et al.⁽¹⁾ at the Institute for Orthopedic Research and Biomechanics, University of Ulm, Germany reported direct in vivo measurements of pressures in the intervertebral disc in 28 body positions (Table 1) utilizing a pressure transducer implanted directly in the nucleus pulposus of a healthy non-degenerated L4-L5 disc of a male volunteer.

The direct measurements of disc pressure by Wilke et al.⁽¹⁾ show unequivocally that the recumbent disc is subject to a pressure that is only a tiny fraction of the pressure exerted on that same disc when the patient is standing and bending forward. Indeed, the pressure exerted on the disc when the patient is standing erect and bending forward is 11 times what the pressure is on the disc when the patient is recumbent.

Additionally, the data corroborates the original intradiscal pressure measurements made by Nachemson et al.⁽²⁾ on the L3-L4 disc of volunteers (Fig. 2 from Nachemson et al.).

Except for the fact that Nachemson found that the maximal disc pressure occurred in the partially flexed erect sitting position, while Wilke et al. found it occurred standing and partially flexed (a variation which could be attributable to the fact that Wilke et al. measured the L4-L5 disc while Nachemson measured the L3-L4 disc), the general result was the same. The upright disc pressure was more than 10 times greater than the recumbent disc pressure. Indeed, the pressure exerted on the upright L3-L4 disc in the seated partially flexed position is also 11 times the pressure the recumbent L3-L4 disc experiences when recumbent, and is the same pressure multiple that Wilke et al. measured.

Table 1. Intradiscal Pressure Values for Different Positions and Exercises - (Wilke et al 1999 Spine 24, #8, p. 755)

Position	Pressure (Mpa)
Lying supine	0.10 ←
Lying on the side	0.12
Lying prone	0.11
Lying prone, extended back, supporting on elbows	0.25
Laughing heartily, lying laterally	0.15
Sneezing, lying laterally	0.38
Peaks by turning around	0.70-0.80
Relaxed standing	0.50
Standing, performing vasalva maneuver	0.92
Standing, bent forward	1.10 ←
Sitting relaxed, without backrest	0.46 ←
Sitting actively straightening the back	0.55 ←
Sitting with maximum flexion	0.83
Sitting bent forward with tight supporting the elbows	0.43
Sitting slouched into the chair	0.27
Standing up from a chair	0.10
Walking barefoot	0.53-0.65
Walking with tennis shoes	0.53-0.65
Jogging with hard street shoes	0.35-0.95
Jogging with tennis shoes	0.35-0.85
Climbing stairs, one stair at a time	0.50-0.70
Climbing stairs, two stairs at a time	0.30-1.20
Walking down stairs, one stair at a time	0.38-0.60
Walking down stairs, two stairs at a time	0.30-0.90
Lifting 20 kg, bent over with round back	2.30
Lifting 20 kg, as taught back in school	1.70
Holding 20 kg close to the body	1.10
Holding 20 kg, 60cm away from the chest	1.80
Pressure increase during night (over a period of 7 hr)	0.10-0.24

.1MPa = 14.5 lbf/in² (pounds force per sq. inch)

These direct intradiscal measurements of disc pressure make it clear that the MR imaging evaluation of the patient upright

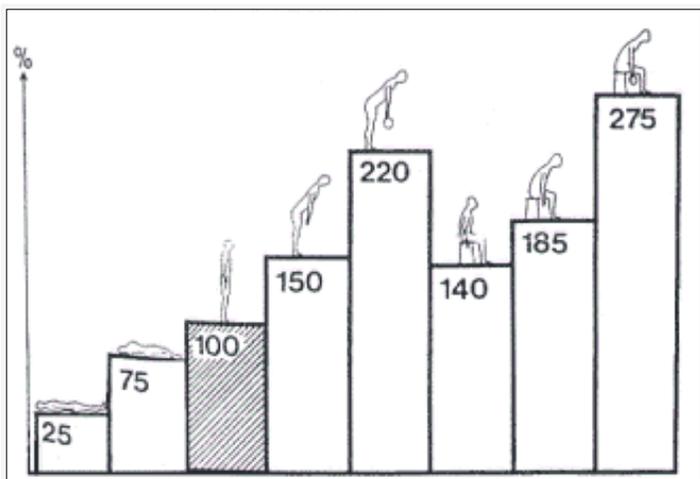


Fig 2. Relative change in pressure (or load) in the third lumbar disc in various positions in living subjects

is the relevant examination, and that the MRI examination of the patient recumbent is not.

According to the Center for Disease Control and Prevention, U.S. Department of Health and Human Services there are 916,000 surgeries of the spine performed each year in the U.S.⁽⁴⁾. The number is comparable in magnitude to the 950,000 cardio-vascular operations performed annually in the U.S., the total of stent placements, coronary bypass surgeries, angioplasties, heart transplants, valve replacements and congenital heart repairs.

Additionally, there are approximately 9,000,000 MRI examinations of the spine performed annually in the U.S

Given that the burden of the spine is to carry weight and that the purpose of these 9,000,000 annual spine MRI examinations is to determine the origin of back pain in these patients, examining the spine with the weight removed in a recumbent-only MRI does not address the patient's need. Indeed, the inadequacy of the weightless

MRI for assessing spinal pathology is self-evident. Direct measurements of intervertebral disc pressure in various body positions prove this fact quantitatively.

Moreover, the recumbent-only MRI examination possesses the risk to the patient of providing the wrong diagnosis and thereby causing the wrong surgery. This outcome carries with it the unfortunate prospect of adding the patient to the ranks of those who make up the high number of "multiply operated surgical cripples"⁽⁵⁾ that comprise the Failed Back Surgery Syndrome (FBSS) (2,6,7,8,9,10,11).

It is thus clear, that for the 916,000 patients who undergo spine surgery each year and for the approximately 9,000,000 patients who receive MRI scans of the spine annually for back pain, that these patients should all be receiving vertical MRI examinations to achieve proper diagnosis of their problems. INDEED THE DATA FROM THE DIRECT IN VIVO MEASUREMENTS OF DISC PRESSURE MAKE IT SELF-EVIDENT THAT IT IS IMPOSSIBLE TO ACHIEVE A CORRECT DIAGNOSIS OF A PATIENT'S BACK PAIN WHEN THE COMPRESSIVE FORCES CAUSING THAT BACK PAIN HAVE BEEN REMOVED.

(1) H-J. Wilke, P. Neef, M. Caimi, T. Hoogland and L. E. Claes, *Spine* 24, #8, pp. 755-762, 1999.

(2) A. L. Nachemson, *Spine* 1, #1, pp. 59-71, 1976

(3) the great majority of back pain patients

(4) National Hospital Discharge Survey: 2003. Vital and Health Statistics Series 13, Number 160, U.S. Department of Health and Human Services Center for Disease Control and Prevention, National Center for Health Statistics, Hyattsville, Maryland

(5) A. L. Nachemson, *Spine* 1, #1, p. 65, 1976

(6) The acronym set aside to identify patients whose symptoms have their origin in prior unsuccessful surgery.

(7) M. Szpalski, R. Gunzburg, Eds., *The Failed Spine*, Lippincott Williams & Wilkins, 2005

(8) M. L. Rowe, *J. Occup Med* 7:196-202, 1965

(9) S. S. Leavitt, T. L. Johnston, R. D. Beyer, *Ind Med Surg* 40:7-14, Nov. 1971

(10) S. S. Leavitt, T. L. Johnston, R. D. Beyer, *Ind Med Surg* 40(9):7-15, Dec. 1971

(11) A. Hakelius, *Acta Orthop Scand* (Suppl 129), 1972

About FONAR

FONAR® was incorporated in 1978, making it the first, oldest and most experienced MRI manufacturer in the industry. FONAR introduced the world's first commercial MRI in 1980, and went public in 1981. Since its inception, FONAR has installed hundreds of MRI scanners worldwide. Their stellar product line includes the FONAR UPRIGHT™ MRI (also known as the Stand-Up™ MRI), the only whole-body MRI that performs Position™ imaging (pMRI) and scans patients in numerous weight-bearing positions, i.e. standing, sitting, in flexion and extension, as well as the conventional lie-down position. The FONAR UPRIGHT™ MRI often sees the patient's problem that other scanners cannot because they are lie-down only. With nearly one half million patients scanned, the patient-friendly FONAR UPRIGHT™ MRI has a near zero claustrophobic rejection rate by patients. A radiologist said, "FONAR UPRIGHT™ MRI - No More Claustrophobia - The Tunnel Is Gone." As another FONAR customer states, "If the patient is claustrophobic in this scanner, they'll be claustrophobic in my parking lot." Approximately 85% of patients are scanned sitting while they watch a 42" flat screen TV. FONAR's latest MRI scanner is the FONAR 360, a room-size recumbent scanner that optimizes openness while facilitating physician access to the patient. FONAR is headquartered on Long Island, New York, and has approximately 400 employees.

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