



Outcome Analysis in Cases of Low Back Pain by Fat Saturation Techniques of Magnetic Resonance Imaging: - A Cross - sectional Rural Hospital Based Study

**Mohd. Arfat^{1*}, Manju Chhugani², Mohd.Faheem³, Alok Kumar⁴, Kailash Kumar Mittal^{5*}
S.P.Singh⁶**

1*- Assistant Professor Medical Imaging Technology Department of Paramedical Sciences
School of Nursing Sciences & Allied Health Jamia Hamdard University, New Delhi-India

2- Professor & Dean School of Nursing Sciences & Allied Health Jamia Hamdard, New Delhi-India

3- Associate Professor Department of Neurosurgery- U.P.U.M.S. Saifai Etawah -India

4- Secretary & Registrar UPSMF & Allied Councils, Lucknow-India

5*- Professor & Head Department of Radiation Oncology U.P.U.M.S. Saifai Etawah-India

6- Professor & Head Department of Surgery U.P.U.M.S. Saifai Etawah-India

***Corresponding Author:**

Prof. (Dr.) Kailash Kumar Mittal

Prof & Head

Department of Radiation Oncology

UPUMS, Saifai. Etawah-India

Email id – drkkmittal@gmail.com

ABSTRACT

Objective: The main objective of conducting this type of study is that to evaluate the clinical application of MR Imaging and their techniques (Fat Saturation, Turbo Spin Echo etc.) with relation of lumbar degenerative disc disease. Normal Radiography (X-rays) of lumbar spine does not useful to find out PIVD, Annular tear, Nerve compression, disc herniation, protrusion, extrusion and lumbar degenerative changes.

Study Design: - Retrospective and observational study.

Methods: A Total 80 cases of suspected Low Back Pain over a period of 3 months were included in this study. Among these 45 were males and 35 females.. All these clinically suspected patients of LBP were imaged by MRI Philips Achieva Nova 1.5T for MR imaging.

Results: Eighty (80) participants took part in the study, out of which 45 (76.85%) were males and 35 (23.145 %) were females. Males were most affected population in this study with lumber lordiosis. L5-S1 disc was the most commonly involved. Annular tear, ligamentum flavum hypertrophy, disc herniation, protrusion, extrusion was common at L4-L5 level. Disc buldge was common L5-S1, L3-L4 level.

Conclusion: Intervertebral disc prolapsed (PIVD) most common cause of Low Back Ache. Normal radiograph of L.S.spine does not helpful to diagnose disc herniation only shows anatomic changes. MRI is the best modality of choice for pathology of intervertebral disc with excellent soft tissue resolution, Multiplanar imaging capability and most important ionizing radiation free technique.

Keywords: PIVD, Low Back Pain (LBP) , Degenerative disc , Magnetic Resonance Imaging

INTRODUCTION— Magnetic Resonance Imaging (MRI) is a radiological imaging modality that uses gyro magnetic property of proton to an image which present in human body in the form of water. Lower back pain (LBP) is most common now a days in male population compare to females and its leads to degenerative disc disease is a condition that affects young to middle-aged persons with peak incidence at approximately 40 years. MRI is considered to the best imaging modality of choice for detecting disc degeneration due to its advantage of being Multiplanar imaging capability, orthogonal planning, and excellent soft-tissue contrast resolution without the risk of Radiation Exposure. The main symptom of disc degeneration after low back ache is along with pain. Redicular pain occurs mostly on one side of the body. It is a sharp shooting type of pain. Mild tingling sensation, dull ache, or burning sensation can occur. Pain may radiate to the calf or sole of the foot. Sciatic pain aggravates on standing, walking, bending, straining and coughing. In some severe case, patient cant not move around [1,2]. Mostly lower back pain (LBP) is the result of an injury, such as muscle strains due to sudden movements and while lifting heavy objects and other factors related with disc degenerative disease are obesity , tall statue , age, smoking ,hereditary & genetic factors [3]. About 70 to 80% of all individuals will experience low back pain (LBP) at some stage in their lives. Unfortunately, a specific clinical diagnosis is not made in most of the cases [4, 5].

Patients suffering with lumbar disc degenerative disease can present with sensory disturbances in legs and having difficulty in bending [6]. Now a day's Low back pain (LBP) is the second most common presenting complaint (after common cold) encountered by health care physicians accounting for the huge socio economic burden and Certain professions like drivers, carpenters and office workers with bad life style are also associated with this type disease [7,8]. The main objective of conducting this type of study is that to evaluate the clinical application of MR Imaging and their techniques (Fat Saturation, Turbo Spin Echo etc.) with relation of lumbar degenerative disc disease. Normal Radiography (X-rays) of lumbar spine is not useful to diagnose PIVD, annular tear, Nerve compression, disc herniation, protrusion, extrusion. Disc desiccation is a common degenerative change of intervertebral discs. It results from the replacement of the glycosaminoglycans within the nucleus pulposus with fibro cartilage which leads to reduced disc height due to reduction in nucleus pulposus volume. Disc degeneration with diffuse disc changes are more commonly found at L4 - L5 and L5 – S1 level and L1 – L2 is least common. This Cranio-caudal direction pattern is also followed by disc herniation. It also can be deduced that lower the lumbar level the higher is the prevalence of disc herniation.

Multiplicity in the disc level involvement is common as compare to the single disc involvement; which is also concordance with past studies. The lower back pain and sciatica were due to nerve root compression, which was significantly associated with disc degeneration.

Aims & Objectives:-

- Characteristics MR Images of the degenerative disc disease in lumbar spine.
- To evaluate extent of the involvement of the degenerative disc disease and its sequel.
- To identify the changes associated with the degenerative disc.

MATERIAL & METHOD:- The present study was a retrospective observational study performed in a Rural Medical Institute of western U.P. and done with 80 cases of suspected Low Back Pain over a period of 3 months attending the Department of Radiology of Uttar Pradesh University of Medical Sciences for MR Imaging were included. Among these 45 were males and 35 females. The study population was selected on the basis of Inclusion and Exclusion criteria given below.. Informed written consent was obtained and the study was cleared by Ethical committee of the Institute. All these clinically suspected patients of LBP were imaged by MRI Philips Achieva Nova 1.5T for MR imaging.

MR-Imaging Parameters:-

Computed tomography (CT) and magnetic resonance imaging (MRI) have been widely adopted for the degenerative spine disease. Indeed, MRI represents a very sensitive technique for the assessment of early degenerative changes of the spine. Routine MRI Sequence T1- and T2-weighted, also using spin echo sequences, and T1,T2 and STIR images in multiple planes followed by contrast enhanced 3 planes T1 weighted FAT saturated images and Multiplanar imaging were performed in all the patients.T2 weighted Fat Saturation Technique (FSE) and T1 weighted with post contrast gadolinium fat sat techniques also added to see the clear pathologic condition. For all cases study was performed on 1.5 Tesla scanners Philips Achieva Nova using 16 channel head coil with TR 1000-2000 ms TE 90-130 ms for T2W and for T1W TR 400-600ms TE 10-15ms with flip angle 90° and slice thickness 3 to 5 mm.

Inclusion Criteria

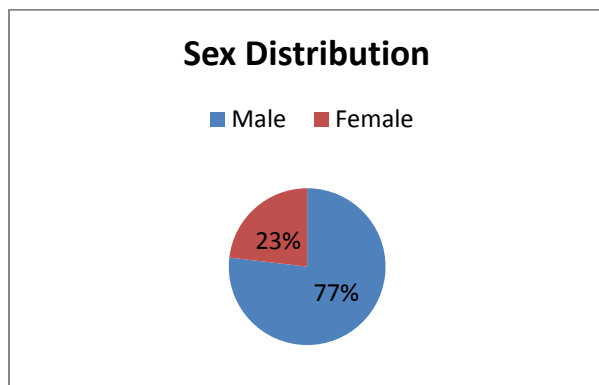
- Patients with history of low back pain (LBP) were included.
- Patients with age between 20 to 70 years were included.

Exclusion Criteria

- Patients having history of Claustrophobia were excluded in this study.
- Patients having history of Trauma, prior surgery, infective spinal disease were excluded in this study.
- Patients having cardiac pacemaker, aneurysm clip, prosthesis and any metallic foreign body in situ were excluded.

- Cases where MRI scanning not possible due to other conditions.

Results:- Total Eighty (80) were studied in the outcome of MRI in Low Back Pain cases. From total 80 patients out of which 45 (76.85%) were males and 35 (23.145 %) were females [Graph-1].



Graph 1- Sex distribution of total (80) studied Patients

The outcome analysis of MRI in total studied (80) patients are as follows:-

Disc Herniation: - A herniated disc occurs when displacement of disc material beyond the limits of the intervertebral disc space. The rubbery disks that lie between the vertebrae in the spine consists of a soft center (nucleus) surrounded by a tougher exterior (annulus). Herniation can be focal or bulging. Disc that become herniated usually are in an early stage of disc degeneration. When herniation is less than 180 degree disc circumference it is called a focal disc herniation and when it is 180 to 360 degree beyond the edges of the ring apophyses it is called disc buldge. In our study mostly affected disc level is L4-L5 and is 42.50% & L5-S1 is 20%. [Table-1/ Fig-1].

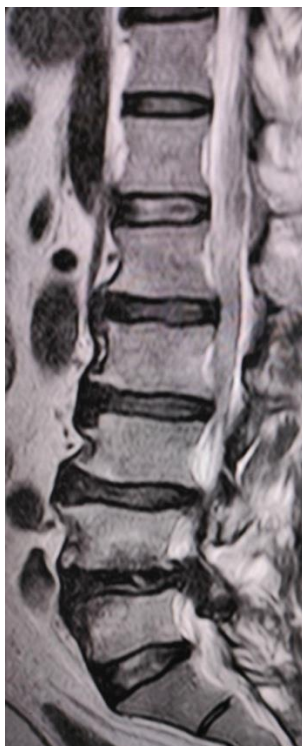


Fig-1- T2 weighted MR image shows disc herniation at L4-L5 Level of lumbar spine

Disc Levels	Disc Herniation n=120	Disc Extrusion/Protrusion n=30	Disc Buldge n=51	Spinal Canal Stenosis n=41	Lateral Recess Narrowing n=81	Facetal Arthropathy n=170	Ligamentum Flavum Hypertrophy n=170
D11-L12	-	-	-	-			
D12-L1	03 (2.5%)	01(3.33%)	04(7.8%)	-	2(2.4%)	3(1.7%)	3(1.7%)
L1-L2	06(5%)	01(3.33%)	7(13.7%)	2(4.8%)	2(2.4%)	13(7.6%)	13(7.6%)
L2-L3	16(13.33%)	03(10%)	6(11.7%)	4(9.7%)	3(3.7%)	30(17.6%)	30(17.6%)
L3-L4	20(16.66%)	05(16.66%)	10(19.6%)	10(24%)	12(14.8%)	40(23.5%)	40(23.5%)
L4-L5	51(42.5%)	12(40%)	16(31.3%)	20(48.7%)	42(51.8%)	60(35.2%)	60(35.2%)
L5-S1	24(20%)	08(26.66%)	08(15.6%)	5(12.1%)	20(24.6%)	24(14.1%)	24(14.1%)

Table-1 Different variables like Disc herniation, Disc Protrusion/Extrusion, Disc Buldge, Spinal Canal Stenosis, Lateral Recess Narrowing, Facetal Arthropathy, Ligamentum Flavum Hypertrophy and their correlation with different Intervertebral disc levels-

Disc Protrusion/ Extrusion:- Disc protrusion indicates that the distance between the edges of the disc herniation is less than the distance between the edges of the base. in which the outermost layers

of the annulus fibrosus of the intervertebral discs of the spine are intact but bulge Whenever the distance between the edges of the disc material is greater than the distance at the base is called as disc extrusion [Table-1/Fig-2].In our Study mostly affected disc level is L4-L5 and is 40 % .

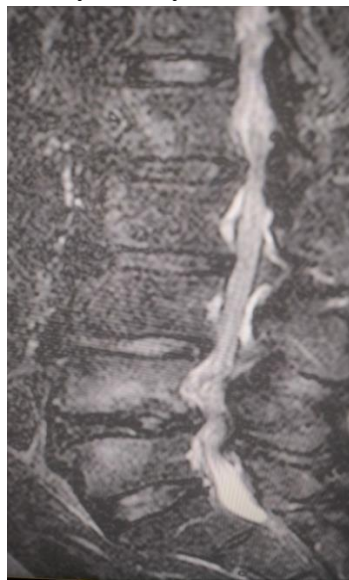


Fig 2- Fat Suppression STIR sequence MR Image shows Disc Extrusion/Protrusion.

Disc buldge:- The disc sags and looks like it is bulging outward like letting air out of a car tire. With a herniated disc, the outer covering of the disc has a hole or tear. This causes the nucleus pulposus (jelly-like center structure) to leak into the spinal canal. [Table-1/Fig-3]. In our Study mostly affected site is L4-L5 Level and is 31.3%.



Fig-3- T2 weighted MR image shows disc buldge at L5-S1 Level of lumbar spine

Annular Tear :- An annular fissure or tear is a deficiency of one or more layers of the annulus fibrosus. Most annular fissures are asymptomatic, but some may be painful. Chronic pain due to annular fissures can be due to granulation tissue or in-growth of nerve endings near the dorsal root ganglion. On magnetic resonance imaging (MRI) T2 sequence, the annular fissure is hyperintense (bright) compared to the rest of the annulus fibrosus (which is normally hypointense) due to the relative increase in water content at the fissure [9]. Annular tear is further classified according to axial location into- central/medial, paramedian/lateral, foraminal/subarticular and extra-foraminal [Table-1/Fig-4].



Fig-4- T2 weighted MR image shows annular Tear of lumbar spine

Ligamentum Flavum Hypertrophy:- Ligamentum flavum hypertrophy is a condition in which the ligamentum flavum (LF) thickens due to stresses placed on the spine. With hypertrophy, ligamentum flavum (LF) increases in thickness (size). The thicker it becomes, the higher the risks of compressing the spinal cord or spinal nerves. Ligamentum flavum thickening was measured on the axial image, perpendicular to the spinal canal axis and parallel to the lamina, where ligamentum flavum were seen along their entire length & measurement were taken at the half length of ligament flavum. According to Park et al., a mean thickness of the ligamentum flavum of 4.44 mm in the patients with the spinal canal stenosis labeled as thickened and 2.44 mm thickness in the control group. So, we had labeled a >4 mm ligamentum flavum thickening as thickened [10] [Table-1/Fig-5]. In our Study mostly affected site is L4-L5 Level and is 35.2%.

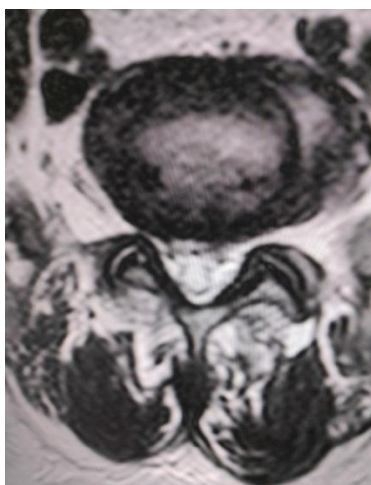


Fig 5 – Axial T2 weighted Image of MRI Sequence shows Ligamentum Flavum Hypertrophy

Spinal Canal Stenosis:- Spinal Stenosis occurs when the space inside the backbone is too small. This can put pressure on the spinal cord and nerves that travel through the spine. Spinal stenosis occurs most often in the lower back and the neck. Narrowing of the spinal canal usually occurs

due to changes associated with aging that decrease the size of the canal, including the movement of one of the vertebrae out of alignment. In the mid Sagittal plane T2 Weighted images spinal canal diameter was measured and Standard MRI sequences was in the lumbar spine include sagittal T1-weighted, T2-weighted, STIR, and proton density-weighted, and axial T1- and T2-weighted sequences. For the evaluation of the spinal canal, Stenosis is compatible with an AP diameter of the canal less than 10 mm in the cervical spine or 12 mm in the lumbar spine. In Our study Spinal canal diameter less than 12 mm in lumbar spine area indicates Stenosis of the canal [Table-1/Fig-6]. In our Study mostly affected site is L4-L5 & L3-L4 Level and is 48.7% & 24% respectively.



Fig 6 – Axial T2 weighted Sag Image of MRI Sequence shows Spinal Canal Stenosis.

Lateral Recess Stenosis: It describes the stenosis of the lateral part of the lumbar spinal canal that is bordered laterally by the pedicle, posteriorly by the superior articular facet, and anteriorly by the vertebral body, endplate margin, and disc margin. [Table-1/Fig-7]. In our Study mostly affected site is L4-L5 Level & L5-S1 level and is 51.8% & 24.6% respectively.



Fig 7- MR axial image shows Lateral recess narrowing

Facetal Arthropathy: Facet Arthropathy is a degenerative condition that affects the spine. The spine is made up of segments of vertebrae running along the spinal column. Between each vertebra are two facet joints. The facet joints along the posterior of the spine help align the vertebrae and limit motion. Facetal arthropathy was noted as reduction in synovial Facetal joint space with loss of high signal intensity on T2 weighted sequences. [Table-1/Fig-8]. In our Study mostly affected site is L4-L5 & L3-L4 Level and is 35.2% & 23.5% respectively.

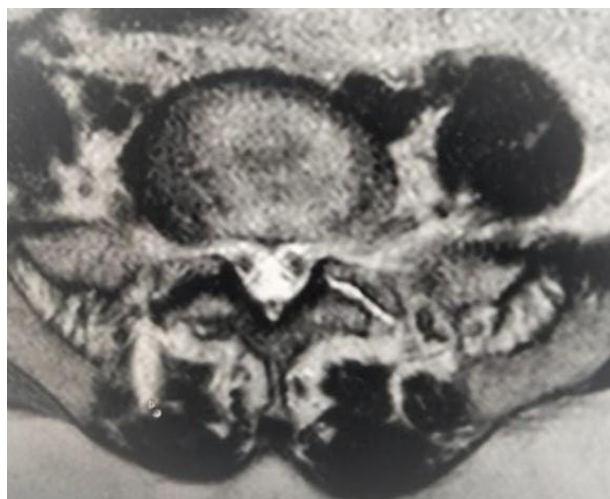


Fig 8- MR axial image shows Facetal Arthropathy

Discussion:- Spinal degenerative disorders, such as disc herniation, spinal Stenosis, and degenerative spondylolisthesis may lead to LBP. According to a joint clinical practice guideline from the American College of Physicians and the American Pain Society, LBP was classified

into three categories: nonspecific LBP, LBP potentially associated with radiculopathy or spinal Stenosis, and LBP potentially associated with another specific spinal cause. Lumbar disc degeneration is the most common cause of low back pain around the world and majority due to the disc herniation. Due to development of MRI, noninvasive excellent imaging of spine is possible. Men are more commonly affected to the disc degeneration than women. It is most likely due to the increased mechanical stress and injury. The findings of our study were consistent with other studies (**Pukhraj & Paola D'Aprile et al**).

Paola D'Aprile, Michelangelo Nasuto, Alfredo Tarantino et al stated that all the patients included in our study protocol suffered of LBP, occasionally radiating to the lower limbs. This work demonstrated these sequences in the study presented population, permitted the complete and better definition of some pathological entities causing LBP. The majority of the patients in our study protocol presented degenerative phenomenon of the intervertebral discs on standard MR scan, consistent with the observation that discs are commonly the primary element of the spinal column that manifest degenerative alterations (11). As with every occurrence of arthrosis, such degenerative phenomena are largely due to genetics, long-term heavy weight-bearing and other complex factors.

From the morphological standpoint, disc degeneration results in loss of height, radial bulging, fissuring of the annulus fibrosus, and disc herniated; MRI remarkably documents such degenerative phenomena to a superior degree than other imaging modalities (12). Among other findings, the degenerated disc demonstrates a reduction in signal intensity on T2-weighted images (principally due to dehydration processes and variations in proteoglycan composition), and a decrease in height; in the more advanced stages of degeneration, the disc fully collapses and may undergo cystic changes, gaseous degeneration and calcification. MRI plays an eminent role in the identification of degenerative phenomena of the spinal facet joints, thereby revealing alterations otherwise unsuspected in other imaging techniques (13, 14). T2-weighted sequences, including those with FS, may show hyperintense signal within the joint space, reflecting joint effusion. T2-hyperintensity and contrast enhancement of the sub chondral bone marrow, in association with the typical degenerative facet alterations, was found in 170 sites cases. Degenerative-inflammatory changes may involve not only the inter spinous and supra-spinous ligaments but also the flavum ligaments in many instances several or all of these structures are involved, at one or at multiple levels, on one or both sides which was observed in 170 sites in our study. Most common sites were L4-L5 (35.2%) followed by L3-L4 (23.5%).

Philipp Näther, Jan Felix Kersten, Ingmar et al stated in their study that - Our study population also showed a correlation between disc height and other characteristics of disc degeneration. Earlier studies described correlations between disc height, patient height, and lifestyle. Because it was not possible to collect data on these potential disruptive factors in our study design.

We cannot rule out the possibility that our study population may be subject to a distortion in this regard. These modifying factors must therefore be taken into account in future studies.

Our data show that initial symptoms of disc degeneration were common and seen in 120 sites with commonest sites being L4-L5 (42.5%) and L5-S1 (20%). Other studies suggested that

women have more severe disc degeneration, albeit in higher age cohorts that we did not investigate [15]. It must be noted that our study only analyzed data from those patients with an indication of lumbar MRI. Based on our own clinical experience, by far the most common indication is lumbar pain due to degenerative changes. The study design did not have the scope to make statements about the extent to which there may be a gender difference between in terms of the indication.

Kasch et al MRI Findings and Back Pain stated in their study that 77.8% of persons with pain at baseline had MRI findings. Disc Degeneration at Lumbar level was found in 60.2% cases and disc herniation at lumbar level in almost 18.4%. Hypertrophy of ligamentum flavum in Lumbar levels in 9.6% and spinal canal stenosis at vertebral levels in 12.4%.

Narayan Bikram Thapa & Suraj Bajracharya stated in their study that out of the 202 patients included in the study, 116 patients (57.4%) were male and 86 patients (42.6%) were female. The mean age of the study population was 44.26 ± 15.61 (13-83) years. Multiple contiguous level disc disease was the most common type of involvement which was noted in 109 (54%) patients. Grade 4 lumbar disc degeneration (graded as per classification given by Pfirrmann et al) was noted in 65.3% (132) cases followed by Grade 2 in 25.2% (51) cases and Grade 1 in 5.5% (11) cases. The most common involvement was observed at L4-L5 level (76.7%) and L5-S1 levels (55.9%) followed by L3-L4 (30.6%) in decreasing order of frequency. The most common category was disc bulge noted in 46.5% (94) of cases. Nerve root compression was observed in 56% (114) of the total cases. Nerve root compromise was also noted most frequently compressing L5 nerve (28.23% of cases). Annular tear was observed in 14.4% (29) of cases and among them 20% (6) of cases had torn at two intervertebral discs. It is most frequently noted involving L4-L5 intervertebral disc (72.5% of cases), followed by L5-S1 (24.2% of cases).

Conclusion:- Magnetic Resonance Imaging (MRI) is the best imaging modality in the evaluation and diagnosis of lower back pain (LBP). Magnetic Resonance Imaging (MRI) provides valuable information regarding the underlying causes of lower back pain (LBP). Communication between radiologists and their surgical colleagues is particularly important in the setting and management of back pain. This common disorder often does not have a definable cause, even when the imaging findings are abnormal. An understanding of various causes of back pain, the universal terminology, and the need of the surgeon are vital to patient treatment. In our study the disc segments most commonly affected by degeneration are L4/L5 and L5/S1. With the aid of our study, we were able to establish an estimation of MRI protocol for the cross-sectional study investigating disc degeneration, which is now underway. This cross-sectional study will record more data, particularly with regard to symptoms, lifestyle, occupational strain, and other illnesses. This data will make possible a more detailed analysis, taking into account potential transitional factors.

Ethical Approval: - The study was approved by the Ethical Committee of U.P. University of Medical Sciences, Saifai, Etawah-India.

Source of Funding: - Not applicable

Conflict of interest: - The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES:-

1. Neuropathy-sciatic nerve; sciatic nerve dysfunction; low back pain-sciatica [Internet]. Bethesda (MD): A.D.A.M. Inc.; c2013 [cited 2012 Aug 12]. Available from: <http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001706/>.
2. Bakhsh A. Long-term outcome of lumbar disc surgery: an experience from Pakistan. *J Neurosurg Spine*. 2010;12:666-70.
3. Battie MC, Videman T, Gibbons LE, Fisher LD, Manninen H, Gill K. 1995 Volvo Award in clinical sciences: determinants of lumbar disc degeneration—a study relating lifetime exposures and magnetic resonance imaging findings in identical twins. *Spine*. 1995;20:2601–12.
4. Reuler JB. Low back pain. *West J Med* 1985; 142:259–265
5. Volinn E. The epidemiology of low back pain in the rest of the world. *Spine* 1997; 22:1747–1754.
6. Modic MT, Ross JS. Lumbar degenerative disc disease. *Radiology*. 2007;245: 43-61.
7. Martin BI, Deyo RA, Mirza SK, et al. Expenditures and health status among adults with back and neck problems. *JAMA* 2008; 299:656–664
8. Shafaq Saleem, Hafiz Muhammad Aslam, Muhammad Asim Khan Rehmani, Aisha Raees, Arsalan Ahmad Alvi, Junaid Ashraf. Lumbar Disc Degenerative Disease: Disc Degeneration Symptoms and Magnetic Resonance Image Findings. *Asian Spine J*. 2013;7(4):322–34.
9. Suthar P, Patel R, Mehta C, Patel N. MRI evaluation of lumbar disc degenerative disease. *J Clin Diagn Res*. 2015 Apr;9(4):TC04-9.
10. Park JB, Chang H, Lee JK. Quantitative analysis of transforming growth factor-beta 1 in ligamentum flavum of lumbar spinal stenosis and disc herniation. *Spine (Phila Pa 1976)*. 2001;26:E492–95.
11. Izzo R, Popolizio T, D'Aprile P, Muto M. Spinal pain. *Eur J Radiol* 2015; 84: 746-756.
12. Jinkins JR. Acquired degenerative changes of the intervertebral segments at and suprajacent to the lumbosacral junction. A radioanatomic analysis of the non discal structures of the spinal column and perispinal soft tissues. *Eur J Radiol* 2004; 50: 134-58.

- 13.** D'Aprile P, Tarantino A, Lorusso V, Brindicci D. Fat saturation technique and gadolinium in MRI of lumbar spinal degenerative disease. *Neuroradiol J* 2006; 19: 654-71.
- 14.** D'Aprile P, Tarantino A, Jinkins JR, Brindicci D. The value of fat saturation sequences and contrast medium administration in MRI of degenerative disease of the posterior/perispinal elements of the lumbosacral spine. *Eur Radiol* 2007; 17: 523-31.
- 15.** Philipp Näther, Jan Felix Kersten, Ingmar Kaden, Kemal Irga and Albert Nienhaus Distribution Patterns of Degeneration of the Lumbar Spine in a Cohort of 200 Patients with an Indication for Lumbar MRI *Int. J. Environ. Res. Public Health* **2022**, 19, 3721