ORIGINAL RESEARCH

Correlation Between MRI Findings, ODI, and VAS Score in Lumbar Disc Herniation

Suada Hasanovic-Vuckovic[1*], Lejla Milisic[1], Lejla Dervisevic[2], Ilvana Hasanbegovic[2], Zurifa Ajanovic[2], Amra Skopljak-Beganovic, Aida Sarac-Hadzihalilovic[2]

[1] Clinic for Radiology, Clinical University Centre of Sarajevo, Sarajevo, Bosnia and Herzegovina
[2] Department of Anatomy, Faculty of Medicine, University of Sarajevo, Sarajevo, Bosnia and Herzegovina
[3] Clinic for Nuclear Medicine, Clinical University Centre of Sarajevo, Sarajevo, Bosnia and Herzegovina

Corresponding Author: Suada Hasanović-Vučković MD, PhD. Department for Radiology, Clinical University Centre of Sarajevo, Sarajevo, Bosnia and Herzegovina; Email: suada2@gmail.com; ORCID ID: https://orcid.org/0009-0006-0644-4560.

Pages: 82 - 91 / Published online: 27 December 2024

Cite this article: Hasanovic-Vuckovic S, Milisic L, Dervisevic L, Hasanbegovic I, Ajanovic Z, Skopljak-Beganovic A, et al. Correlation Between MRI Findings, ODI, and VAS Score in Lumbar Disc Herniation. Sar Med J. 2024; 1(2): Online ahead of print. 10.70119/0021-24

Original submission: 1 September 2024; **Revised submission:** 1 November 2024; **Accepted:** 17 December 2024

Abstract

Introduction. Magnetic resonance imaging (MRI) is the preferred method for diagnosing the causes of lumboischialgia, as it offers the highest sensitivity and specificity compared to other imaging techniques. In clinical practice, there is often a notable discrepancy between patients' clinical symptoms and the radiological findings. While there are various clinical tests for lumboischialgia, the Oswestry Disability Index (ODI) and the Visual Analogue Score (VAS) are the most commonly used and reliable. This article aims to explore the correlation between patients' subjective pain experiences and their level of disability due to lumboischialgia and disc herniation as detected by MRI.

Methods. In this prospective clinical study, a total of 100 patients of both genders, aged 18 to 65 years, were included. These patients were referred for magnetic resonance imaging of the lumbar spine due to complaints of lumboischialgia. MRI of the lumbar spine was performed, and the extent of degenerative changes was evaluated. Participants completed a questionnaire regarding their subjective pain experience and functional status, and the Oswestry Disability Index (ODI) and Visual Analogue Score (VAS) were calculated.

Results. The statistical analysis revealed a significant correlation between the severity of disc herniation (classification) and the intensity of spinal pain ($p = 0.010$), as well as with the disability index ($p = 0.003$).

Conclusion. A statistically significant relationship was confirmed between the levels of pain and disability and the degree of intervertebral disc herniation observed on MRI images of the lumbar spine.

Keywords: lumbal disk herniation, lumboischialgia, pain.

INTRODUCTION

Back pain is one of the most prevalent clinical conditions among middle-aged individuals, affecting over 85% of the global population at least once in their lifetime. This condition is a leading cause of visits to family medicine practitioners, work absenteeism, and high healthcare costs. It significantly impacts quality of life, often leading to anxiety, depression, and other psychosomatic changes, particularly in cases of chronic pain.

Back pain encompasses a range of spinal disorders that are among the most common ailments in modern society. Epidemiological data indicate that between 50% and 80% of adults will experience low back pain (lumbar syndrome) at some point in their lives. Although low back pain can occur at any age, it is most prevalent between the ages of 35 and 55, affecting both sexes equally. After menopause, women are somewhat more likely to experience it, and during pregnancy, between 49% and 76% of women report low back pain. It is the leading cause of disability in adults under 45 and ranks third among those over 45. Approximately 5% of men and 2.5% of women suffer from sciatica, with pain most commonly localized in the lumbar or cervical spine. Back pain serves as a symptom rather than a standalone disease, with a wide range of potential causes—up to 150 different factors are noted. The most common cause is degenerative changes in the intervertebral discs and the small joints of the vertebrae. Lumbar disc herniation occurs when disc material is displaced beyond the normal boundaries of the intervertebral space, leading to pain, weakness, or tingling in specific dermatomes or myotomes. This condition typically affects the L4-L5 and L5-S1 levels, causing pain that can radiate to the gluteal region, down the back of the leg, across the top of the foot, and into the big toe if originating from the L5 nerve root. If stemming from the S1 nerve root, the pain may travel along the gluteal area, down the back of the leg, to the heel, lateral side of the foot, and into the little toe. This type of pain is particularly challenging due to its high incidence and chronic nature. Magnetic resonance imaging (MRI) is the preferred diagnostic tool for identifying the causes of lumboischialgia, owing to its superior sensitivity and specificity compared to other imaging methods. MRI provides detailed anatomical visualization and effectively highlights pathologies, particularly in soft tissues, without the use of ionizing radiation. In addition to radiological techniques, various clinical tests are employed to evaluate and diagnose the patient's condition. The Oswestry Disability Index (ODI) and the Visual Analogue Score (VAS) are the most commonly used and reliable tools. These assessments include questions about the intensity of lumbar pain and the impact on nine daily activities (such as personal care, lifting, walking, sitting, standing, sleeping, sexual activities, social life, and travel). Several studies have explored the relationship between radiological findings and patient symptoms related to lumbar pain; however, many had methodological limitations, often relying on retrospective symptom descriptions without standardized approaches. Utilizing standardized tools, like ODI and VAS, has improved the accuracy and reproducibility of symptom assessments.

The aim of our study was to determine whether there is a correlation between patients' subjective pain experiences and their level of disability related to lumboischialgia and disc herniation, as detected by MRI.

METHODS

Patients and Study Design

Following approval from the Ethical Committee (0302-56/13) of the University Clinical Center of Sarajevo, this research was conducted as a randomized prospective study from 2021 to 2023 at the Radiology Clinic of the University Clinical Center of Sarajevo. The study included 100 patients of both genders, aged 18 to 65, who presented a clear clinical picture of lumboischialgia and were referred for MRI. Medical documentation provided insights into clinical findings (from neurologists, orthopedists, or neurosurgeons), laboratory results, and demographic data.

Patients were excluded if they did not have a confirmed clinical diagnosis of lumboischialgia, had undergone prior spinal surgery, had other conditions affecting the clinical presentation (such as post-stroke status, amputations, or severe diabetes with neuropathy), or if their symptoms were due to other pathological processes in the lumbar

spine (including inflammatory processes, tumors, or trauma) rather than degenerative changes. Additionally, patients with incomplete medical records or those who declined to participate were not included.

Methods

All eligible patients underwent an MRI scan of the lumbar spine while lying supine, with a pillow placed under their knees, using an appropriate spinal coil. No prior preparation was required, and no intravenous contrast medium was administered.

MRI was performed using 1.5 Tesla machines (Magnetom Avanto, Siemens; Toshiba Titan; GE Signa Exite). A standard protocol was employed for the lumbosacral region, including T1 and T2 turbo spin echo (TSE) sequences in sagittal orientation, T2 TSE in coronal orientation, fat-suppressed T2 trim in sagittal, and axial T1 and T2 TSE sequences.

The MRI scans were analyzed for lumbar disc herniation, using Jensen's and MSU classification systems. Jensen's classification divides disc herniation into four categories:

1. **Bulging**: Minor bulging of the disc without disruption of the annulus fibrosus.
2. **Protrusion**: Larger disc bulge with partial annulus fibrosus defect.
3. **Extrusion**: Complete rupture of the annulus fibrosus and posterior longitudinal ligament.
4. **Sequestration**: The central part of the disc breaches the annulus fibrosus and enters the spinal canal.

Using the MSU classification, we determined the size and location of the herniations based on a single measurement at the point of greatest extrusion, at the level of the intrafacet line (a transverse line joining the medial edges of the right and left facet joints).

The size of the herniated disc was categorized as follows:

1. A herniation extending to or less than 50% of the distance from the posterior aspect of the normal disc to the intrafacet line.
2. A herniation extending more than 50% of that distance.
3. A herniation that fully extends beyond the intrafacet line. In cases of caudal or cranial (maximal) extrusions, the measurement was taken from the posterior edge of the vertebra instead of the disc.

Three points (A, B, and C) were marked along the intrafacet line to quantify the location of the disc herniation. Vertical lines were drawn through these points to define the right and left central quadrants (Zone A) and the right and left lateral quadrants (Zone B). Zone C was identified at the level of the foramen, extending beyond the medial margin of any facet joint into the lateral quadrants.

In addition to MRI scans, all patients completed a questionnaire regarding their subjective pain experience and functional status, allowing for the calculation of ODI and VAS scores. VAS scores were reported on a scale from 0 to 10, where 0 indicates no pain, 5 indicates moderate pain, and 10 signifies unbearable pain. The total ODI points were divided by 50 and multiplied by 100 to yield a percentage of disability, categorized as follows: 0-20% (minimal disability), 21-40% (moderate disability), 41-60% (severe disability), 61-80% (disabled), and 81-100% (immobile or exaggerating symptoms).

Statistical Analysis

All collected data were statistically analyzed using SPSS software, version 16. Descriptive statistics were calculated, including arithmetic means, medians, standard deviations, and standard errors. The degree of correlation was assessed using the Pearson or Spearman correlation coefficients, with a significance level set at $p < 0.05$.

RESULTS

The most significant disc herniations among the patients examined were observed at the L4–L5 (47%) and L5–S1 (39%) levels, with only 3% of patients having no hernia (Figure 1). The most common type of herniation was protrusion (73%), while arch tension and extrusion were somewhat less frequent; sequestration was not detected in the analyzed group.

The study results indicated a significant correlation between the severity of disc herniation (classification) and the intensity of spinal pain (p = 0.010), as well as the disability index (p = 0.003). Patients with extrusion reported the highest pain levels (mean VAS = 8; ODI = 50%), while those with arch tension reported the least pain (mean VAS = 6; ODI = 32%) (Figure 2).

Nerve compression was confirmed in 48% of the patients, with no significant gender difference (p = 0.678). Patients with observed compression on MRI reported greater pain levels. Compression was more frequently noted on the left side (33.3%), followed by the right side (38.6%), bilate-

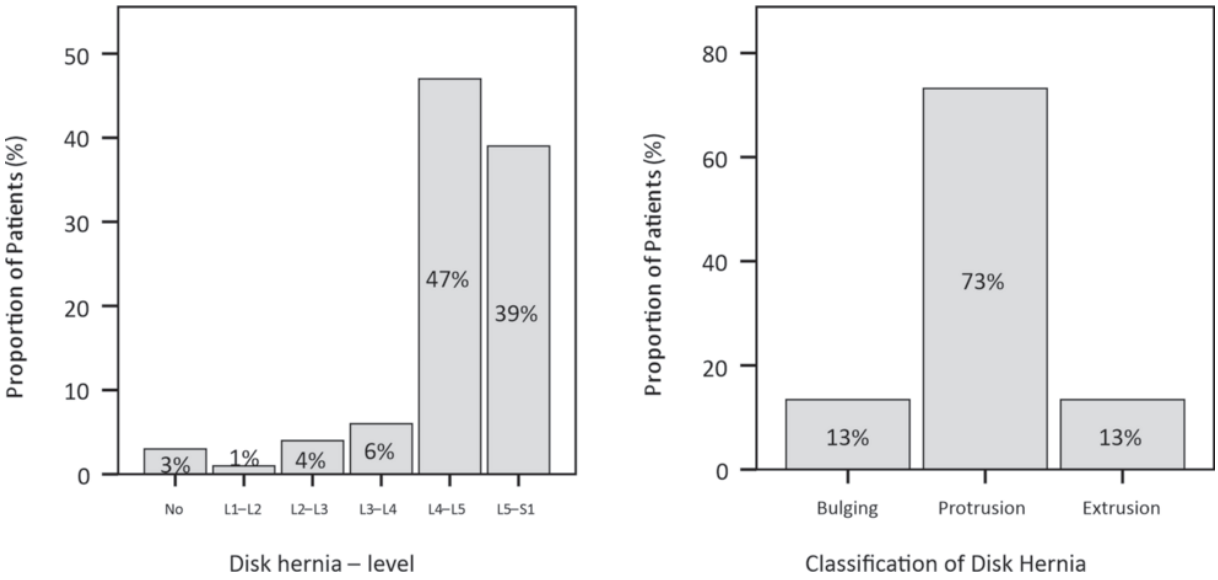

Figure 1. Proportion in the total number of patients: (left) location of disc herniation; (right) classification of herniated disc

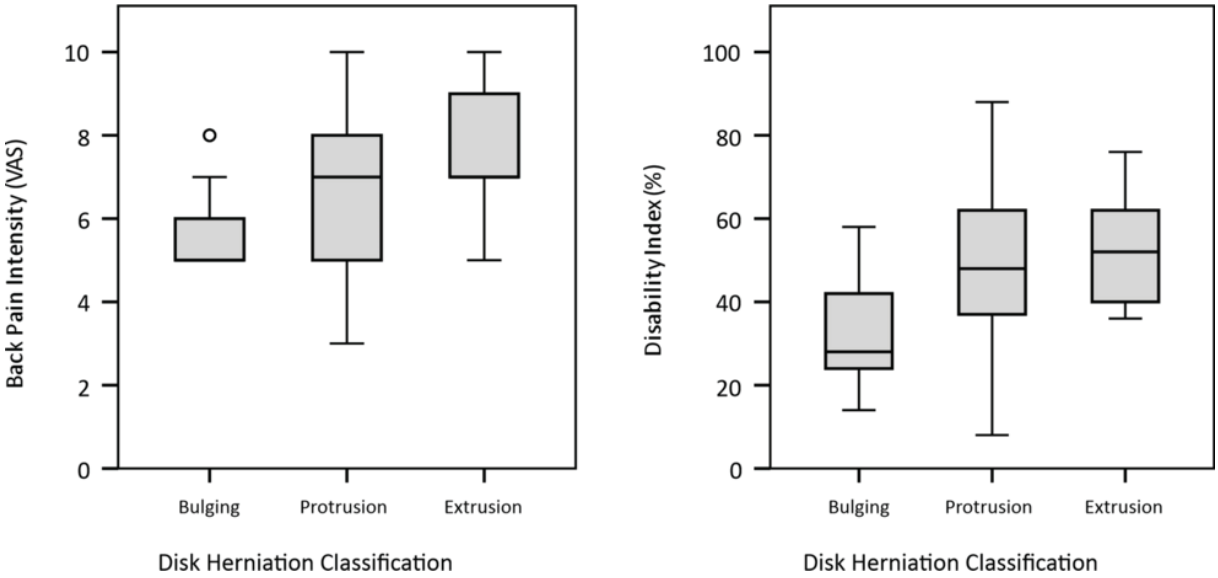

Figure 2. (left) Back Pain Intensity (VAS) and (right) Disability Index (ODI) depending on disc herniation classification

rally (14.0%), and somewhat less often on the dural sac (14.0%). There were no significant differences in VAS and ODI scores based on the sites of compression (Figure 3). However, there was a significant difference in spinal pain intensity (p = 0.006) and disability index (p = 0.001) between patients with nerve compression and those without.

No significant differences were found in spinal pain intensity (p = 0.957) and disability index (p = 0.358) concerning the location of foraminal stenosis (Figure 4).

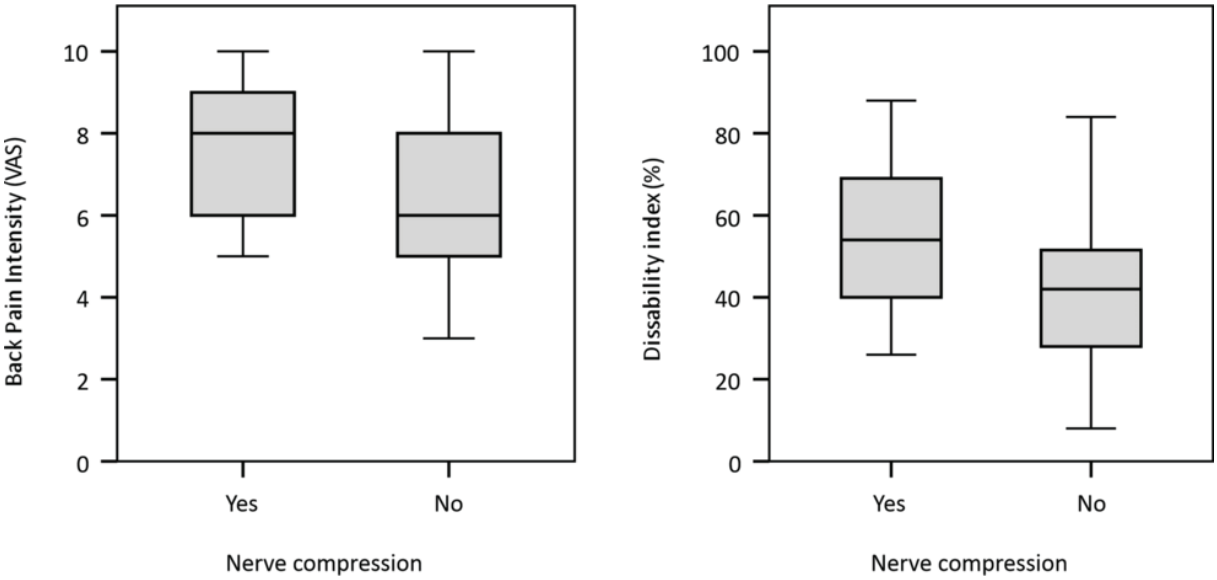

Figure 3. (left) Back Pain Intensity (VAS) and (right) Disability Index (ODI) depending on the presence of nerve compression.

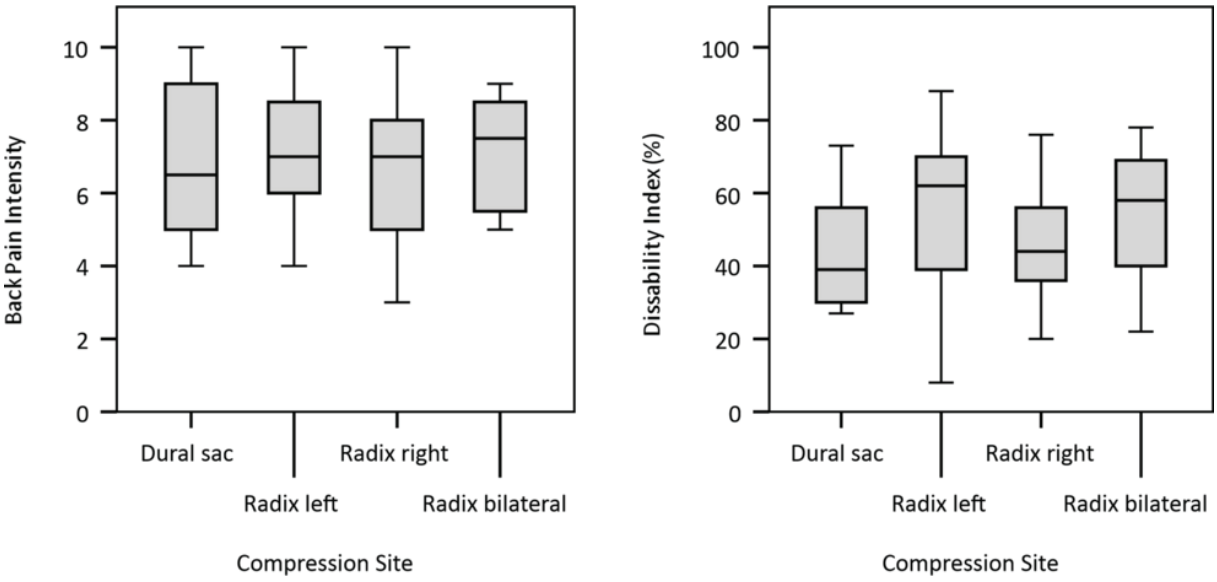

Figure 4. (left) Back Pain Intensity (VAS) and (right) Disability Index (ODI) depending on the compression site.

The most common MSU grade among patients (Figure 5) was 2-AB (34.3%), indicating a size 2 hernia that extends both centrally (A) and laterally (B). Older patients exhibited higher MSU grades (p = 0.002), as shown in the quantile plot (Figure 5).

VAS and ODI scores correlated positively with the MSU grade and severity of herniation (ranging from mildest 1-A to most pronounced 3-AB). The quantile plots illustrated a clear positive correlation between these variables (Figure 6), with significant findings for both VAS (p = 0.006) and ODI (p = 0.001)

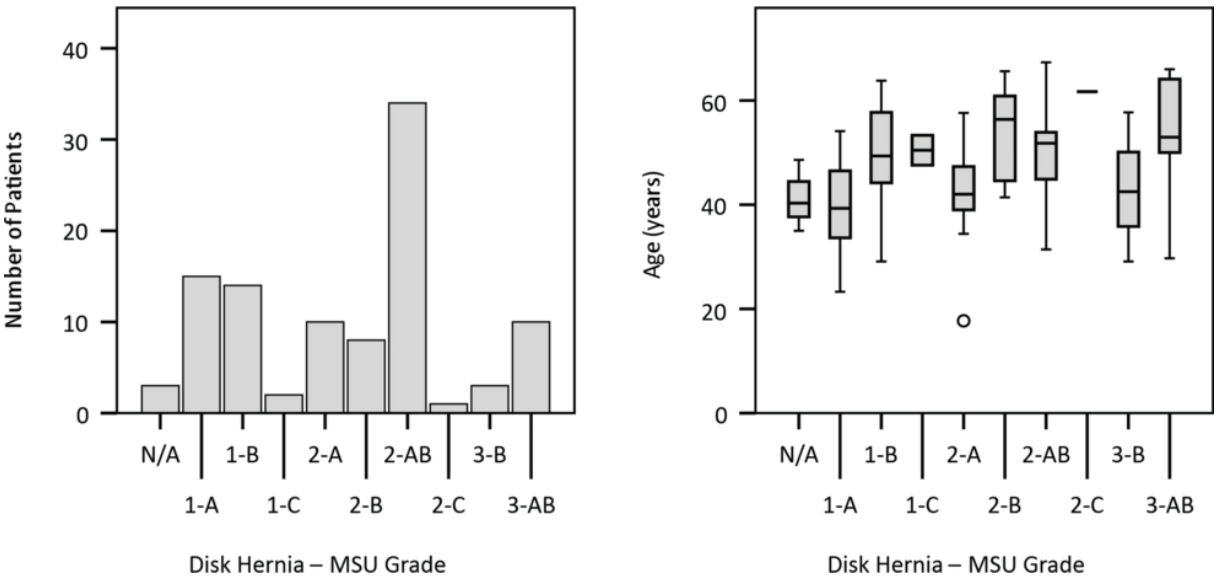

Figure 5. (left) Frequency of different MSU grades in the examined group of patients and (right) dependence of age on MSU grade.

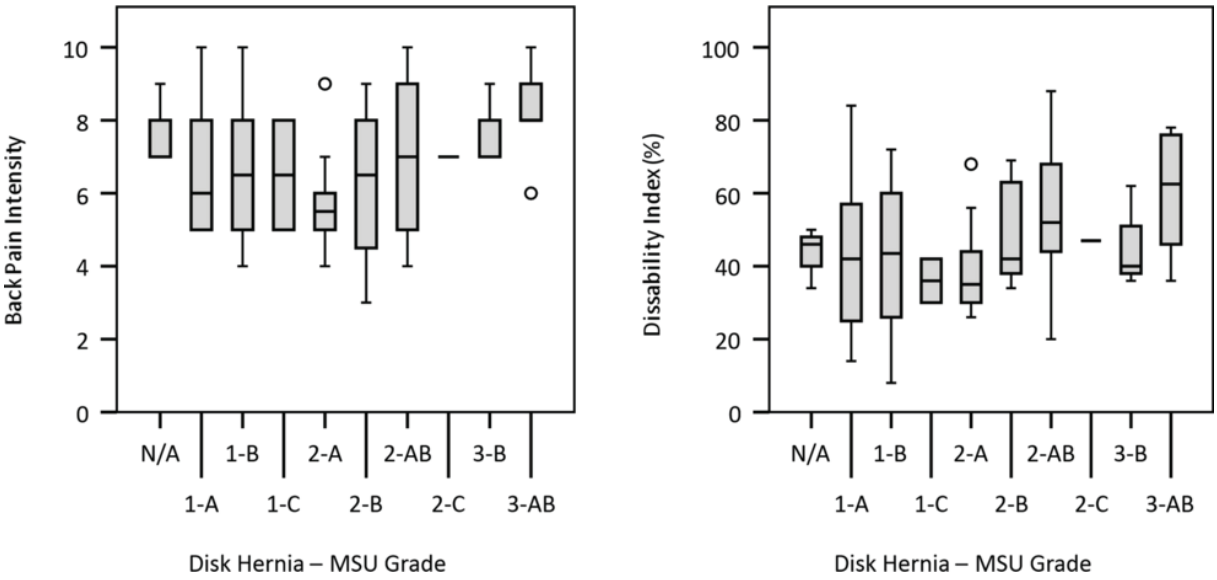

Figure 6. (left) Back Pain Intensity (VAS) and (right) Disability Index (ODI) depending on MSU grade of disc herniation.

DISCUSSION

Lumbar pain is among the most prevalent musculoskeletal disorders encountered in clinical practice, affecting an estimated 25% to 60% of individuals, making it a leading cause of disability and work inability in those under 50. Nearly 80% of people globally experience this condition at least once in their lifetime, with intervertebral disc changes, particularly herniation, being the most common source of lower back pain (15, 16). Our study aimed to investigate the relationship between MRI findings of intervertebral disc herniation in the lumbar spine and the clinical symptoms of patients, assessed using the ODI index and VAS score. Pain is a highly subjective experience that can vary significantly among patients, regardless of MRI results. Various factors can influence the perception of pain in individuals with lumboschialgia. Herniated intervertebral discs are frequently implicated in lumbar pain, with the L4-5 level showing the highest incidence of degenerative changes (47%), followed by L5-S1 (39%), and only 3% of patients lacking disc herniation. These findings align with previous studies (17, 18, 19). Bajpai et al. reported that

36% of patients had L4/L5 intervertebral discs involved in herniation, while only 3% were affected at the L1/L2 level (18). These figures are consistent with Modic et al.'s findings of 43% at L4/L5, echoing results from Garrido (20, 21). Protrusion was the most common type of herniation, observed in 73% of patients, while arch tension and extrusion were less frequent. Our study demonstrated a significant correlation between the severity of disc herniation (classification) and the intensity of spinal pain ($p = 0.010$), as well as the disability index ($p = 0.003$). Patients with extrusion reported the highest pain levels (mean VAS = 8; ODI = 50%), while those with arch tension reported the lowest (mean VAS = 6; ODI = 32%). These findings differ from those of Corniola et al. and Bajpai et al. (18, 22). El-Hady et al. observed protrusion in 48% of examined discs, with extrusion and sequestration occurring in 6.5% of cases, and only 13% displaying normal morphology (23). In our study, we evaluated functional disability using the ODI index, finding the highest scores among patients with extrusion (ODI = 50%) and the lowest among those with arch tension (ODI = 32%). The ODI questionnaire has been shown to be both reproducible and valid for assessing disability in lumboschialgia patients (24, 25). Dunsmuir found no significant correlation between disc prolapse size or location and patient symptoms, arguing that patient symptoms should guide therapy choices (26). El-Hady emphasized that clinicians should not rely solely on MRI findings for diagnosing lumboschialgia, noting the multifactorial nature of lower back pain and a lack of correlation between MRI findings and pain intensity, contrary to our results. While we found a relationship between the ODI index and MRI findings, El-Hady suggested the ODI primarily serves to enhance patient confidence and minimize unnecessary tests (23). We concur with Beattie et al. that disc extrusion is closely associated with symptoms, noted in 13% of our extrusion group (27).

Our results are somewhat inconsistent with existing literature. Some studies indicate that ODI scores are not significantly influenced by the level of spinal changes or the degree of stenosis. Conversely, Sigmundsson's studies found a correlation between increased MRI intervertebral changes and elevated ODI scores, suggesting potential utility in diagnosing lumbar spinal stenosis (28, 29, 30). In our cohort, 48% of patients exhibited nerve compression, more frequently on the left than the right, with 14% experiencing bilateral compression and another 14% having dural sac compression. Patients with nerve compression reported significantly greater back pain intensity ($p = 0.006$) and a higher disability index ($p = 0.001$) compared to those without. No significant differences in pain intensity or disability were observed based on the location of foraminal stenosis ($p = 0.957$; $p = 0.358$). These findings align with Bajpai et al., who noted radiculopathy in 54% of patients, distributed evenly between sides, and six with bilateral radiculopathy (18). Vroomen and colleagues reported a higher rate of nerve compression at 67% (31). Hirsch et al. found a strong association between neurological symptoms and disc herniation, with 86% of patients testing positive for the Lesegue sign (32).

Utilizing the MSU classification for herniated discs, we analyzed both the size and location of hernias. The predominant MSU grade among patients was 2-AB (34.3%), indicating a size 2 hernia extending both centrally (A) and laterally (B). We identified a correlation between the MSU grade of disc herniation and patient age ($p = 0.002$), consistent with findings from Ma et al. and Howard et al. (33, 34). Our results demonstrated that VAS and ODI scores correlate with the ordinal variable linking MSU grade and herniation severity (from mildest 1-A to most severe 3-AB). A positive correlation was found between VAS ($p = 0.006$) and ODI scores ($p = 0.001$).

Hosseini et al. sought to evaluate MSU classifications for better patient selection for ozone therapy, noting older patients exhibited higher MSU grades, which aligns with our findings. The mean initial VAS score across all patients was 7.5 ± 0.8, and the average initial ODI score was 48% ± 1%.

While all groups showed improvement post-therapy, statistically significant differences were noted in the magnitude of improvement. Group 2-AB demonstrated the least pain reduction and improvement in ODI scores, possibly due to the larger size of hernias in that cohort (35). Mysliwiec et al. found that one year post-surgery, 71 of 75 patients in MSU groups 2-A and 2-B reported excellent outcomes, while only 3 of 6 patients in group 2-C did (12).

Janardhan et al. aimed to correlate MRI abnormalities with clinical characteristics of lumbar prolapse, finding that centrolateral bulging or extrusion with significant foraminal damage closely aligned with clinical signs and symptoms, whereas central bulging and disc arc tension showed poor correlation. They concluded that foraminal damage plays a crucial role in determining clinical outcomes, while the type of herniation (bulging, extrusion, or protrusion) has a weaker association (36).

Our study has limitations. We did not account for other important independent variables that could influence our results, such as weight, height, BMI, education level, smoking habits, and lumbar spine strength and flexibility. We also did not assess patient physical activity levels, despite literature indicating a strong connection between sedentary lifestyles and back pain, with moderate physical activity linked to reduced pain (37, 38). Additionally, we did not examine whether sensory deficits correlated with lumbar disc prolapse and nerve root compression. Addressing these factors could enhance our understanding of the results.

CONCLUSION

VAS and ODI scores correlate with an ordinal variable that connects MSU grade with the severity of herniation.

Acknowledgment: None.

Declaration of patient consent: The authors confirm that they have obtained all necessary patient consent forms. Each patient has provided written consent to participate in this study.

Authors' Contributions: SHV, LD and LM contributed to the study design, data collection, and interpretation. SHV, LD, LM, IH, ASB, ASH and ZA were involved in writing, analyzing, and giving final approval of the manuscript. Each author participated in drafting the article and in the revision process. All authors approved the final version for publication and agree to take responsibility for all aspects of the work, ensuring that any questions regarding the accuracy or integrity of any part are properly addressed and resolved.

Financial support and sponsorship: None.

Conflict of interest: The authors have nothing to disclose.

REFERENCES

1. Duarte ST, Moniz A, Costa D, Donato H, Heleno B, Aguiar P, Cruz EB. Low back pain management in primary healthcare: findings from a scoping review on models of care. BMJ Open. 2024;14(5):e079276. doi: 10.1136/bmjopen-2023-079276.
2. Wu A, March L, Zheng X, Huang J, Wang X, Zhao J, et al. Global low back pain prevalence and years lived with disability from 1990 to 2017: estimates from the Global Burden of Disease Study 2017. Ann Transl Med. 2020;8(6):299. doi: 10.21037/atm.2020.02.175.
3. Zileli M, Oertel J, Sharif S, Zygourakis C. Lumbar disc herniation: Prevention and treatment of recurrence: WFNS spine committee recommendations. World Neurosurg X. 2024;22:100275. doi: 10.1016/j.wnsx.2024.100275.
4. Waxenbaum JA, Reddy V, Williams C, Futterman B. Anatomy, Back, Lumbar Vertebrae. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023.
5. Pojskic M, Bisson E, Oertel J, Takami T, Zygourakis C, Costa F. Lumbar disc herniation: Epidemiology, clinical and radiologic diagnosis WFNS spine committee recommendations. World Neurosurg X. 2024;22:100279. doi: 10.1016/j.wnsx.2024.100279.
6. Yu P, Mao F, Chen J, Ma X, Dai Y, Liu G, et al. Characteristics and mechanisms of resorption in lumbar disc herniation. Arthritis Res Ther. 2022;24(1):205. doi: 10.1186/s13075-022-02894-8.
7. Li J, Jia J, Wu T, Yuan J, Tang T, Jiang Z, et al. Accuracy of Coronal Magnetic Resonance Imaging Diagnosis of Multi-Segmental Lumbar Disc Herniation: A Single-Center Retrospective Analysis. Med Sci Monit. 2023;29:e938577. doi: 10.12659/MSM.938577.

8. Lin TY, Wang YC, Chang CW, Wong CB, Cheng YH, Fu TS. Surgical outcomes for upper lumbar disc herniation: decompression alone versus fusion surgery. J Clin Med. 2019;8(9):1435. doi: 10.3390/jcm8091435.
9. Yao M, Xu BP, Li ZJ, Zhu S, Tian ZR, Li DH, et al. A comparison between the low back pain scales for patients with lumbar disc herniation: validity, reliability, and responsiveness. Health Qual Life Outcomes. 2020;18(1):175. doi: 10.1186/s12955-020-01403-5.
10. Mysliwiec LW, Cholewicki J, Winkelpleck MD, Eis GP. MSU classification for herniated lumbar discs on MRI: toward developing objective criteria for surgical selection. Eur Spine J. 2010;19:1087-93. doi: 10.1007/s00586-010-1296-3.
11. Abouelmaaty EH, Molla ES. Reliability (Revalidation) of MSU MRI Classification of Lumbar Disc Herniation in 100 Patients Series: Severity and Objective Surgical Criteria. Egypt Spine J. 2016;17:5-16. doi: 10.1097/ESJ.0000000000000001.
12. d'Ercole M, Innocenzi G, Ricciardi F, Bistazzoni S. Prognostic Value of Michigan State University (MSU) Classification for Lumbar Disc Herniation: Is It Suitable for Surgical Selection? Int J Spine Surg. 202;15(3):466-70. doi: 10.14444/8068.
13. Delgado DA, Lambert BS, Boutris N, McCulloch PC, Robbins AB, Moreno MR, et al. Validation of digital visual analog scale pain scoring with a traditional paper-based visual analog scale in adults. J Am Acad Orthop Surg Glob Res Rev. 2018;2(3):e088. doi: 10.5435/JAAOSGlobal-D-17-00088.
14. Fairbank JC, Pynsent PB. The Oswestry disability index. Spine. 2000;25(22):2940-53. doi: 10.1097/00007632-200011150-00017.
15. Silva MC, Fassa AG, Valle NC. Chronic low back pain in a Southern Brazilian adult population: prevalence and associated factors. Cad Saude Publica. 2004;20(2):377-85. doi: 10.1590/S0102-311X2004000200016.
16. Andersson GB. Epidemiological features of chronic low-back pain. Lancet. 1999;354(9178):581-5. doi: 10.1016/S0140-6736(99)01312-4.
17. Ravikanth R. Magnetic resonance evaluation of lumbar disc degenerative disease as an implication of low back pain: a prospective analysis. Neurol India. 2020;68(6):1378-84. doi: 10.4103/0028-3886.302899.
18. Bajpai J, Saini S, Singh R. Clinical correlation of magnetic resonance imaging with symptom complex in prolapsed intervertebral disc disease: a cross-sectional double-blind analysis. J Craniovert Junct Spine. 2013;4(1):16-20. doi: 10.4103/0974-8237.112462.
19. Singh R, Kumar P, Wadhwani J, Yadav RK, Khanna M, Kaur S. A comparative study to evaluate disc degeneration on magnetic resonance imaging in patients with chronic low back pain and asymptomatic individuals. J Orthop Trauma Rehabil. 2021;28:1-7. doi: 10.1016/j.jotr.2021.04.001.
20. Garrido E. Lumbar disc herniation in the pediatric patient. Neurosurg Clin N Am. 1993;4:149-52. doi: 10.1016/S1042-3680(20)30043-5.
21. Modic MT, Ross JS. Magnetic resonance imaging in the evaluation of low back pain. Orthop Clin North Am. 1991;22:283-301. doi: 10.1016/S0030-5898(20)30053-7.
22. Corniola MV, Stienen MN, Joswig H, Smoll NR, Schaller K, Hildebrandt G, Gautschi OP. Correlation of pain, functional impairment, and health-related quality of life with radiological grading scales of lumbar degenerative disc disease. Acta Neurochir. 2016;158(3):499-505. doi: 10.1007/s00701-015-2617-9.
23. El-Hady AO, El Molla SS, Elwan SI, Rehab IA. Evaluation of health-related quality of life with the use of Oswestry disability index in degenerative discogenic low back pain. Egypt Rheumatol Rehabil. 2023;50:4. doi: 10.1186/s43166-023-00325-6.
24. Arpinar VE, Gliedt JA, King JA, Maiman DJ, Muftuler LT. Oswestry disability index scores correlate with MRI measurements in degenerating intervertebral discs and endplates. Eur J Pain. 2020;24(2):346-53. doi: 10.1002/ejp.1526.
25. Hasanovic-Vucković S, Jusufbegovic M, Vegar-Zubovic S, Milisic L, Sehic A, Hasanbegovic I, et al. Assessment of lumbar spine disc degeneration in coherence to Pfirrmann grades and Oswestry disability index. J Health Sci. 2020;10(10):1-5. doi: 10.17532/jhsci.2020.1189.
26. Dunsmuir RA, Nisar S, Cruickshank JA, Loughenbury PR. No correlation identified between the proportional size of a prolapsed intravertebral disc with disability or leg pain. Bone Joint J. 2022;104-B(6):715-20. doi: 10.1302/0301-620X.104B6.BJJ-2021-1341.R1.
27. Beattie PF, Meyers SP, Stratford P, Millard RW, Hollenberg GM. Association between patients' reports of symptoms and anatomic impairment visible on lumbar magnetic resonance imaging. Spine (Phila Pa 1976). 2000;25:819-28. doi: 10.1097/00007632-200003010-00023.
28. Sigmundsson FG, Kang XP, Jönsson B, Strömqvist B. Correlation between disability and MRI findings in lumbar spinal stenosis. Acta Orthop. 2011;82:204-10. doi: 10.3109/17453674.2011.553467.
29. Middendorp M, Vogl TJ, Kollias K, Kafchitsas K, Khan MF, Maataoui A. Association between intervertebral disc degeneration and the Oswestry Disability Index. J Back Musculoskelet Rehabil. 2017;30:819-23. doi: 10.3233/BMR-170835.
30. Hong JH, Lee MY, Jung SW, Lee SY. Does spinal stenosis correlate with MRI findings and pain, psychologic factor, and quality of life? Korean J Anesthesiol. 2015;68:481. doi: 10.4097/kjae.2015.68.5.481.
31. Vroomen PC, de Krom MC, Wilmink JT, Kester AD, Knottnerus JA. Diagnostic value of history and physical examination in patients suspected of lumbosacral nerve root compression. J Neurol Neurosurg Psychiatry. 2002;72:630-4. doi: 10.1136/jnnp.72.5.630.
32. Hirsch C, Ingelmark BE, Miller M. The anatomical basis for low back pain. Studies on the presence of sensory nerve endings in ligamentous, capsular, and intervertebral disc structures in the human lumbar spine. Acta Orthop Scand. 1963;33:1-17. doi: 10.3109/17453676309150845.
33. Ma D, Liang Y, Wang D, Liu Z, Zhang W, Ma T, et al. Trend of the incidence of lumbar disc herniation: decreasing with aging in the elderly. Clin Interv Aging. 2013;8:1047-50. doi: 10.2147/CIA.S45793.

34. Howard SA, Vaccaro A, Simeone FA, Balderston RA, O'Neill D. Herniated lumbar disc in patients over the age of fifty. J Spinal Disord. 1990;3(2):143-6. doi: 10.1097/00002517-199003000-00009.
35. Hosseini B, Taheri M, Sheibani K. Comparing the results of intradiscal ozone injection to treat different types of intervertebral disc herniation based on MSU classification. Interv Neuroradiol. 2019;25(1):111-6. doi: 10.1177/1591019918807975.
36. Janardhana AP, Rajagopal, Rao S, Kamath A. Correlation between clinical features and magnetic resonance imaging findings in lumbar disc prolapsed. Indian J Orthop. 2010;44(3):263-9. doi: 10.4103/0019-5413.64080.
37. Çakmak A, Yücel B, Özyalçın SN, Bayraktar B, Ural HI, Duruöz MT, Genç A. The frequency and associated factors of low back pain among a younger population in Turkey. Spine. 2004;29:1567-72. doi: 10.1097/01.brs.0000139427.10115.04.
38. Heneweer H, Vanhees L, Picavet SJH. Physical activity and low back pain: a U-shaped relation? Pain. 2009;143:21-5. doi: 10.1016/j.pain.2009.02.013.