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MRI of Chronic Low Back Pain: Correlation Between Pain, Disability, and Disc Herniation

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Abstract

Chronic low back pain (cLBP) typically presents as pain radiating from the back into the dermatome of the affected nerve root. Magnetic resonance imaging (MRI) is the preferred diagnostic tool for evaluating the spine in patients with cLBP. The objective of this study is to investigate the relationship between pain, disability, and disc herniation, focusing on patients with severe disc prolapse (grade 3). The research included 70 participants, with pain intensity measured for both back and leg discomfort using the visual analog scale (VAS). The Roland Morris Disability Questionnaire (RMDQ-Arabic version) was used to assess the degree of disability. After clinical examination, each patient underwent MRI imaging of the spine and lower extremities. The severity of disc displacement and nerve root compression were classified using the Michigan State University (MSU) disc herniation classification. The data were analyzed using SPSS version 23.0, with Pearson's correlation coefficients computed to explore relationships between variables. Descriptive statistics such as means and standard deviations were determined for each factor. The results showed no significant correlation between a low-grade disc herniation and a VAS score of 3. The Pearson correlation values for grade 3 disc herniation (r = -0.212) and disability (r = 0.17) were both weak. In addition, the relationship between pain intensity and functional disability was weak (r = 0.159). The findings suggest that clinical symptoms and magnetic resonance imaging findings should be used together to decide on therapeutic intervention, as there was only a weak link between pain intensity, disability, and the grade of disc herniation.

Keywords: Disability, Disc herniation, IVDP, Chronic low back pain, MRI

Introduction

The study revealed no significant link between a Visual Analog Scale (VAS) score of 3 and low-grade disc herniation, based on MRI data. Both disc herniation (r = -0.212) and functional disability (r = 0.17) showed weak Pearson correlation coefficients at grade three. Furthermore, a weak association was found between pain intensity and functional disability in this study. Chronic low back pain (cLBP) is a prevalent condition, affecting approximately 80% of individuals at some point in their lives. In around 80% of these cases, disc degeneration is the underlying cause of the pain [1]. Individuals with disc herniation, or intervertebral disc prolapse (r = 0.159), face numerous mechanical challenges, especially from disc degeneration, which can occur due to poor posture or spinal injuries resulting from spinal flexion or rotation, particularly during physical activities or back extensions [2]. Disc degeneration is the primary contributor to back pain [3]. The neuromuscular system plays a vital role in maintaining the biomechanical integrity and stability of the spine [4-6]. Disability and pain can worsen due to weakened back muscles, fatigue, and reduced spinal mobility in those with chronic low back pain [7, 8]. To ensure spinal health, trunk muscles must contract properly and maintain a balance between opposing muscle groups [8, 9]. Pain can delay the contraction of back muscles, increasing the risk of further spinal injury and dysfunction of the lumbar spine [9, 10].

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Maintaining proper contraction of trunk muscles and balance is essential for spinal health [11-13]. MRI is particularly valuable for visualizing how the intervertebral disc connects with surrounding soft tissues and neural structures [14, 15]. It is used to identify soft tissue pathologies around the spine and assess conditions within the spinal cord and canal [16, 17]. MRI can evaluate the size, location, and extent of disc herniations, which play a significant role in the prognosis of patients with intervertebral disc prolapse (IVDP) [18]. Interestingly, some patients with similarly sized herniations may exhibit symptoms, while others do not [19]. Hence, clinical correlation is critical before considering treatment interventions for cLBP patients to avoid misinterpreting abnormal MRI results [20]. The objective of this study is to investigate the relationship between pain, disability, and disc herniation, focusing on patients with severe disc prolapse (grade 3).

Materials and Methods

This study involved 70 participants who were referred to the Radiology Department of King Khalid Hospital in Hail for MRI scans of the lower back between January and December 2022, following ethical approval. Only grade 3 disc herniations, as classified by the Michigan State University grading system, were included in the study [21]. Both male and female participants aged 20 to 60 years were eligible, provided they had no cognitive impairments. Exclusion criteria included prior spinal surgeries, trauma, rheumatologic conditions, spinal infections, participation in a structured spine exercise program within three months before the study, spinal fractures, congenital spine abnormalities (such as scoliosis and kyphosis), spondylolisthesis, pregnancy, cancer, ankylosing spondylitis, fibromyalgia, myofascial pain, or visceral issues. Additionally, individuals with aortic aneurysms, cerebral or carotid clips, or heart pacemakers were excluded due to absolute contraindications to MRI. After explaining the study procedures, including the visual analog scale (VAS), Roland Morris disability questionnaire (RMDQ), and MRI scanning, written consent was obtained from each participant.

Descriptive statistics were used to analyze demographic data such as age, gender, occupation, height, and weight. An information booklet was provided to participants, which included details about the study, along with a form to document their data (name, age, gender, height, weight, symptom duration) and complete the VAS and RMDQ.

Pain assessment

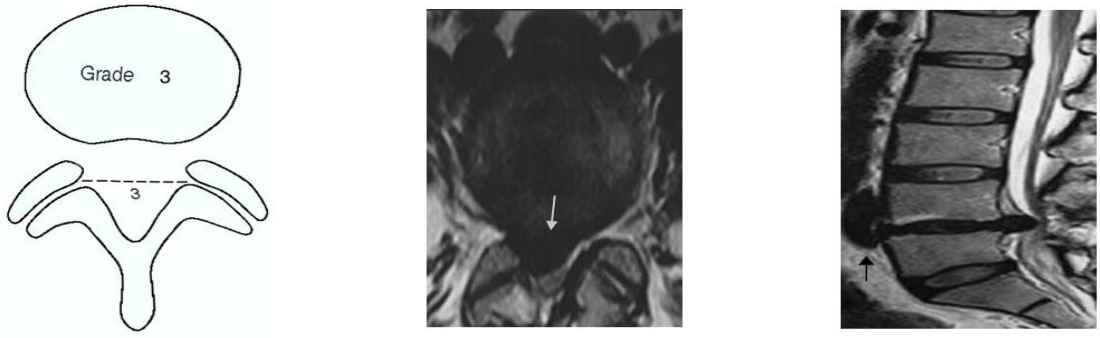
The Visual Analog Scale (VAS) was used to measure pain intensity. The scale ranges from 0 (no pain) on the left to 10 (severe pain) on the right. Participants were asked to indicate their current pain level on the scale, with higher numbers reflecting more intense pain.

Functional disability assessment

Functional disability related to low back pain (LBP) was assessed using the Roland Morris Disability Questionnaire (RMDQ), a tool that evaluates the impact of LBP on daily activities. The questionnaire asks participants to select the statement that best describes their symptoms, and the final score is calculated by summing the number of boxes checked. Scores range from 0 (no disability) to 24 (severe disability), with scores of 11 and 18 indicating mild and moderate disability, respectively [21].

Magnetic resonance imaging (MRI) procedure

MRI scans were conducted with all participants in a supine position using a 1.5T Siemens Avanto scanner equipped with a 24-element body spine surface coil. Both T1- and T2-weighted sagittal and axial MRI sequences were performed using turbo spin echo imaging. The MRI procedure included T1-sagittal sequences, T1-axial multi-stack and angle, T2-sagittal sequences, T2-axial sequences, T2-STIR sagittal sequences, and T2-axial multi-stack and angle **(Figure 1)**.



a) b) c)

Figure 1. a) An MRI showing L4-L5 lumbar disc herniation as grade 3, b) an MRI showing axial T2 weighted image, and c) sagittal T2

The MRI findings from L1 to S1 were assessed by two musculoskeletal radiologists using uniform evaluation protocols. Lumbar disc herniation was analyzed following the Michigan State University (MSU) classification system [16], as depicted in **Figure 1**.

Statistical procedures

Data analysis was carried out with SPSS software, version 23.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics, such as age, symptom duration, height, weight, and the mean and standard deviation of VAS scores, were computed. The Pearson correlation coefficient was used to assess the relationships between MRI findings, including pain intensity (VAS), functional disability (RMDQ), and grade 3 disc herniation.

Results and Discussion

The demographic data, including height, age, weight, and symptom duration, were used to calculate the mean values **(Table 1)**. A total of 70 individuals with grade-3 disc herniations were included in the study, consisting of 35 males (50 percent) and 35 females (50%). The average age of the participants was 39 ± 11.7 years, with ages ranging from 19 to 62 years. Among the patients, 37 had grade-3 disc herniations classified as AB type, while 22 presented with the B type. Only 11 individuals (15.7%) had type A herniation, and all 11 cases were identified as such **(Table 2)**.

Table 1. Demographic data

Variables	Mean ± SD
Age (years)	39 ± 11.7
Weight (kg)	78 ± 7.6
Height (cms)	169.8 ± 8.17
Duration (days)	92 ± 7.73

Table 2. Distribution of the subjects

	MSU [grade 3]
A	11 [15.7%]
B	22 [31.4%]
AB	37 [52.8%]

*MSU: Michigan State University Classification

The analysis revealed no statistically significant association between the severity of lumbar disc herniation and the gender of the participants (P = 0.487). On average, individuals reported pain intensity of eight out of ten on the VAS, while their functional impairment, measured using the RMDQ, averaged 16 out of 23. For those diagnosed with disc herniation at the L4-L5 level, the mean VAS score was 7.2 ± 1.3, whereas at the L5-S1 level, it was slightly higher at 7.9 ± 1.19. The relationship between grade-3 disc herniation and both pain severity and functional disability was minimal, with Pearson correlation values of r = -0.212 (P = 0.17) for pain and r = 0.197 (P = 0.49) for disability. Additionally, among patients experiencing intense chronic low back pain, the link between VAS-measured pain levels and RMDQ-based functional limitation was also weak (r = 0.159; P = 0.51) as shown in **Table 3**.

Table 3. Correlation between pain, disability, and level of disc prolapse

	'r' value	Interpretation
Pain and disability	0.159	Weak correlation
Pain and MSU	-0.212	Weak correlation
Disability and MSU	0.197	Weak correlation

*MSU: Michigan State University Classification.

This investigation sought to evaluate the clinical relevance of anatomical deviations observed via MRI by analyzing the symptoms associated with grade-3 disc herniation and correlating them with imaging outcomes.

Chronic low back pain remains the most prevalent musculoskeletal issue globally, and disc herniation stands as a major contributor to this burden [22]. While several factors contribute to low back pain, lumbar disc degeneration is widely recognized as the leading cause, with disc herniation emerging as a direct result of such degeneration. MRI is regarded as the most precise modality to grade nerve root compression in cases of lumbar disc deterioration. Unlike earlier investigations that focused solely on male participants [23–25], the present study included both men and women.

Chronic low back pain arises due to a range of factors, including age, lifestyle, and previous medical history [26]. Studies have demonstrated that obesity significantly increases the likelihood of experiencing LBP, with obese individuals exhibiting a 5.7-fold higher risk compared to those maintaining a normal body mass index [27]. Moreover, lifestyle practices, particularly physical activity levels, play a role in the onset of cLBP. Research suggests that individuals engaging in minimal physical training are more prone to developing intense back pain than those who follow more rigorous exercise routines [27].

Our analysis indicated that clinical characteristics, demographic information, and MRI observations exhibit only weak associations with the degree of pain and functional impairment in both male and female patients. This aligns with findings from an autopsy analysis involving 647 lumbar spinal segments, which documented frequent disc degeneration at the L4–L5 level [28]. Although pathology often presents at L4–L5, the prevalence and intensity were not as pronounced as described in previous reports [29]. While a connection between pain intensity, functional limitation, and cLBP was observed, this study found the relationship to be weak [30]. This could be partially attributed to the relatively younger age group of participants, with the average age reported as 39 ± 11.7 years in our cohort. Literature indicates that pain intensity is a key predictive factor for disability in patients with chronic low back pain based on multivariate analysis [31]. Disability assessments offer a reliable reflection of the extent of pain and also provide insight into the transition from acute to chronic pain [32], as well as act as indicators of functional recovery, such as return-to-work potential [33]. Disc herniation may present with significant clinical symptoms and an elevated disability risk [34].

In contrast to earlier research, our findings demonstrated only a marginal correlation between reported pain levels and disability. Prior studies have suggested that functional disability correlates not only with pain severity but also with variables such as psychological distress, exhaustion, social support, financial burdens, and employment status [35]. MRI performed in a weight-bearing (upright) position can be particularly helpful for detecting degenerative disc changes in individuals with chronic low back pain [36]. Notably, MRI studies on asymptomatic individuals have revealed disc irregularities in approximately 30% of cases [37], and these individuals still exhibited high rates of low back pain [38]. Numerous studies have explored the clinical impact of degenerative findings in spinal imaging [39], although long-term investigations on how these structural changes relate to future disability remain limited [40]. The frequency of disc bulges and protrusions appears to peak during the fifth and sixth decades of life [41], which is consistent with trends seen in our patient group.

Among the limitations of this research are the relatively small sample size and its confinement to a single clinical setting. Additionally, key factors such as BMI, mental health variables (e.g., depression and anxiety), economic conditions, smoking history, and other psychosocial influences were not evaluated. Furthermore, asymptomatic individuals were not included as a control group in this study.

Conclusion

Findings from this research suggest that among individuals experiencing chronic low back pain, there is no substantial association between grade-3 disc herniations in the lumbar region and the severity of pain or level of functional impairment. Therefore, it is recommended that healthcare providers adopt a more holistic approach when evaluating MRI findings, taking into consideration the full clinical picture rather than relying solely on the presence of disc herniation in explaining lower back pain symptoms.

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