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To Estimate MRI Findings in Chronic Low Back Pain Due to Degenerative and Paraspinal Muscle Changes and Its Correlation with Modified Oswestry Disability Index

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Abstract

Background: *Chronic low back pain (CLBP) is a leading cause of disability and reduced quality of life worldwide, often arising from degenerative changes in the lumbar spine and associated paraspinal musculature. Magnetic Resonance Imaging (MRI) provides critical insight into both osseous and soft tissue alterations in CLBP, including disc degeneration, Modic changes, facet joint arthropathy, spinal canal narrowing, and fatty infiltration or atrophy of the paraspinal muscles. However, the clinical impact of these MRI findings remains controversial, particularly in relation to the patient's functional disability as measured by tools like the Modified Oswestry Disability Index (mODI).*

Aim: *To evaluate MRI-based degenerative changes and paraspinal muscle alterations in patients with chronic low back pain and correlate these findings with the Modified Oswestry Disability Index.*

Materials and Methods: *A prospective cross-sectional study was conducted at a tertiary care center involving 100 patients aged 20–70 years presenting with CLBP (pain duration >12 weeks). MRI of the lumbosacral spine was performed using a 1.5T system. Parameters assessed included intervertebral disc degeneration (Pfirrmann grading), Modic changes, presence of Schmorl's nodes, facet joint hypertrophy, spinal canal or foraminal stenosis, and cross-sectional area and fatty infiltration of paraspinal muscles (particularly multifidus and erector spinae). The severity of disability was assessed using the Modified Oswestry Disability Index (mODI). Correlations between imaging findings and mODI scores were analyzed using Spearman's rank correlation and logistic regression.*

Results: *Degenerative disc changes were present in 91% of patients, with Pfirrmann grade III and IV being the most common. Modic changes were observed in 48% of cases, predominantly type II. Facet joint arthropathy was seen in 57%, and spinal canal stenosis in 32% of patients. Paraspinal muscle atrophy was evident in 66% of the sample, with multifidus muscle fatty infiltration graded as moderate to severe in 43%. A significant positive correlation ($r = 0.61$, $p < 0.001$) was noted between higher mODI scores and severity of paraspinal muscle changes. Disc degeneration and Modic changes also showed moderate correlation with mODI ($r = 0.42$ and $r = 0.38$, respectively). Regression analysis identified multifidus fatty infiltration and spinal stenosis as independent predictors of higher disability.*

Conclusion: *MRI plays a crucial role in identifying structural and muscular abnormalities in CLBP. Paraspinal muscle atrophy and fatty infiltration, more than bony degenerative changes, showed stronger correlation with functional disability. These findings suggest that targeted rehabilitation focused on muscle preservation may be key in managing chronic low back pain and improving quality of life.*

Keywords: *Chronic Low Back Pain, MRI, Degenerative Spine, Paraspinal Muscle Changes, Multifidus, Oswestry Disability Index, Modic Changes, Lumbar Spine, Spinal Stenosis, Disc Degeneration*

INTRODUCTION

Chronic low back pain (CLBP) is a major global health concern and one of the most frequent causes of disability among adults. With a lifetime prevalence of approximately 60–80%, it significantly impacts individuals' quality of life and imposes a substantial socioeconomic burden **[1]**. According to the Global Burden of Disease Study 2019, over 568 million people worldwide suffer from low back pain, making it the leading cause of years lived with disability. Despite its widespread occurrence, the etiology of CLBP is often multifactorial and remains

poorly understood in many cases, especially due to the lack of specific clinical or imaging markers that consistently correlate with symptom severity [2]. Magnetic Resonance Imaging (MRI) has become the gold standard for non-invasive evaluation of spinal structures due to its superior soft tissue contrast and multiplanar capability. It facilitates detailed assessment of intervertebral disc degeneration, Modic changes of the vertebral endplates, facet joint arthropathy, ligamentous thickening, spinal canal narrowing, and subtle osseous abnormalities such as Schmorl's nodes or vertebral osteophytes [3]. Disc degeneration is typically graded using the Pfirrmann classification, which evaluates signal intensity, disc height, and structural integrity. Modic changes, categorized into types I (inflammatory), II (fatty), and III (sclerotic), provide additional insight into endplate pathology and have been increasingly studied for their role in chronic spinal pain [4]. However, a major limitation in current imaging practice is the frequent disconnect between radiological findings and clinical symptoms, as many degenerative features are also present in asymptomatic individuals.

Recently, attention has shifted to the paraspinal muscles, particularly the multifidus and erector spinae, which are integral to dynamic spinal stability and proprioception. Chronic pain, disuse, and neuromuscular deconditioning contribute to atrophy and fatty infiltration of these muscles, which may further exacerbate spinal dysfunction [5]. MRI techniques allow reliable measurement of the cross-sectional area (CSA) and qualitative assessment of fatty replacement within these muscles, particularly at the L4–L5 level. Emerging evidence suggests that changes in paraspinal muscle morphology may be more strongly associated with pain chronicity and functional impairment than traditional bony changes [6]. However, comprehensive studies integrating both spinal degenerative features and muscular alterations, and relating them to patient-reported functional outcomes, remain limited. The Modified Oswestry Disability Index (mODI) is a widely accepted questionnaire that quantifies disability resulting from low back pain. It evaluates ten domains of daily function and generates a cumulative score expressed as a percentage of disability [7]. Despite its clinical utility, few studies have directly correlated specific MRI abnormalities whether discal, osseous, or muscular with mODI scores in a structured, comparative framework. Given the high prevalence of CLBP and the inconsistencies in correlating imaging with functional status, there is a pressing need to explore whether specific MRI parameters can reliably predict patient-reported disability. Understanding such correlations would enhance diagnostic precision and help stratify patients for individualized management plans, especially in resource-limited settings. Most importantly, if muscular changes prove to have stronger predictive value, it could redirect clinical attention toward early physiotherapeutic and rehabilitative interventions aimed at restoring muscle integrity rather than focusing solely on spinal structural changes. The present study was undertaken with the dual objective of systematically evaluating degenerative and paraspinal muscle changes on MRI in patients with chronic low back pain and correlating these imaging features with functional disability as assessed by the Modified Oswestry Disability Index. Through this approach, the study aims to bridge the gap between radiological diagnosis and functional assessment, ultimately improving patient outcomes through targeted and evidence-based interventions.

MATERIALS AND METHODS

Study Design and Setting: This prospective cross-sectional observational study was carried out over a duration of twelve months in the Department of Radiodiagnosis at a tertiary care teaching hospital located in central India. Ethical approval for the study was obtained from the institutional ethics committee prior to initiation, and all participants provided written informed consent after being fully briefed about the purpose and procedures involved in the study.

Study Population: The study population comprised 100 patients between the ages of 20 and 70 years who presented with chronic low back pain, defined as pain localized to the lower back region persisting for a duration longer than 12 weeks. Patients were recruited from the outpatient departments of orthopedics, neurology, and physical medicine. All included participants underwent a detailed clinical history and examination, followed by MRI evaluation of the lumbosacral spine and completion of the Modified Oswestry Disability Index questionnaire to assess their level of functional disability.

Inclusion Criteria: Patients were eligible for inclusion if they were between 20 and 70 years of age, reported a history of low back pain lasting longer than 12 weeks, had not undergone any previous spinal surgeries, and were mentally and physically capable of completing the mODI questionnaire.

Exclusion Criteria: Patients were excluded if they had acute back pain of less than 12 weeks' duration, prior spinal surgery, known spinal infections, traumatic spinal injuries, congenital vertebral anomalies, spinal tumors

or metastases, or neurological deficits that necessitated emergency management. Incomplete imaging or refusal to participate also led to exclusion.

MRI Protocol: All patients underwent MRI of the lumbosacral spine using a 1.5 Tesla MRI scanner. Imaging was performed with the patient in supine position using a lumbar spine phased-array coil. The following sequences were acquired: T1-weighted sagittal and axial, T2-weighted sagittal and axial, STIR sagittal, and axial T2-weighted fat-saturated images. Slice thickness was maintained at 4 mm with an interslice gap of 0.5 mm. All MRI scans were reviewed on PACS independently by two radiologists with a minimum of five years' experience in musculoskeletal imaging. Any discrepancies in findings were resolved by mutual consensus.

MRI Parameters Evaluated: Intervertebral disc degeneration was assessed using the Pfirrmann grading system across all lumbar levels from L1–L2 to L5–S1. Modic changes at vertebral endplates were categorized as type I (hypointense on T1 and hyperintense on T2), type II (hyperintense on T1 and isointense or hyperintense on T2), or type III (hypointense on both T1 and T2). The presence of Schmorl's nodes, vertebral osteophytes, and disc bulges or herniations were documented. Facet joint degeneration was graded based on joint space narrowing, hypertrophic changes, and sclerosis, and classified as mild, moderate, or severe. Spinal canal and foraminal stenosis were assessed visually and categorized as mild, moderate, or severe based on the degree of cerebrospinal fluid effacement and nerve root compression.

Paraspinal muscle morphology was evaluated with specific attention to the multifidus and erector spinae muscles. The cross-sectional area was measured on axial T2-weighted images at the L4–L5 level. Fatty infiltration was visually graded using a semi-quantitative scale as follows: grade 0 (no fat), grade 1 (<25% fatty infiltration), grade 2 (25–50%), and grade 3 (>50%). To account for inter-patient variability, measurements were normalized to the vertebral body area at the same level.

Modified Oswestry Disability Index Assessment: All patients completed the mODI questionnaire in their preferred language, with verbal clarification provided if required. The mODI includes ten sections covering pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, traveling, and employment or home-making. Each section is scored from 0 to 5, and the cumulative score is converted into a percentage to determine disability level. The final scores were interpreted as follows: 0–20% (minimal disability), 21–40% (moderate disability), 41–60% (severe disability), 61–80% (crippled), and 81–100% (bed-bound or symptom exaggeration).

Statistical Analysis: Data from the study were compiled in Microsoft Excel and analyzed using IBM SPSS version 25. Descriptive statistics including frequencies, percentages, means, and standard deviations were used to summarize demographic and imaging data. Correlation between MRI findings and mODI scores was assessed using Spearman's rank correlation coefficient. Categorical variables such as Modic changes, muscle grading, and severity of stenosis were compared across disability categories using the chi-square test. Non-parametric comparisons of mODI scores across MRI grades were performed using the Kruskal-Wallis test. Multivariate logistic regression was used to identify independent MRI predictors of higher disability (mODI score ≥40%). A p-value of less than 0.05 was considered statistically significant.

RESULT

The present study included 100 patients with chronic low back pain who underwent MRI evaluation and were assessed using the Modified Oswestry Disability Index (mODI). The data were analyzed with respect to demographic variables, clinical disability grading, and detailed MRI findings including intervertebral disc degeneration, Modic changes, facet joint arthropathy, spinal stenosis, and paraspinal muscle morphology—specifically fatty infiltration in the multifidus muscle. A total of 12 tables have been presented to illustrate the frequency and pattern of these findings and their correlation with functional disability. The results highlight significant associations between moderate to severe muscle degeneration and higher mODI scores, along with contributions from spinal canal stenosis and disc pathology.

Table 1: Age and sex distribution of patients with chronic low back pain.

Table 1 shows the demographic profile of the 100 patients enrolled in the study. The majority of patients were in the 41–60 year age group, highlighting the midlife predominance of chronic low back pain. A slight female preponderance was observed, indicating a gender-based variation in healthcare-seeking behavior or underlying pathology.

Age group (years)	Male (n)	Female (n)	Total (n)	Percentage (%)
20–30	5	7	12	12.0
31–40	10	8	18	18.0
41–50	13	14	27	27.0
51–60	12	15	27	27.0
61–70	9	7	16	16.0
Total	**49**	**51**	**100**	**100.0**

Table 2: Duration of low back pain among study participants.

Table 2 shows the distribution of patients based on the duration of symptoms. The majority of patients (42%) reported a symptom duration between 3–6 months, followed by 33% who had symptoms persisting for 6–12 months. Only 7% had chronic pain for more than 2 years.

Duration of CLBP	Number of patients (n)	Percentage (%)
3–6 months	42	42.0
6–12 months	33	33.0
1–2 years	18	18.0
>2 years	7	7.0
Total	**100**	**100.0**

Table 3: Modified Oswestry Disability Index (mODI) scores among study subjects.

Table 3 shows the disability grades based on mODI scoring. Moderate disability was most common (38%), followed by severe disability (26%). A small proportion of patients were categorized as crippled (6%) or bed-bound (3%).

mODI Score (%)	Disability Grade	Number of patients (n)	Percentage (%)
0–20	Minimal disability	11	11.0
21–40	Moderate disability	38	38.0
41–60	Severe disability	26	26.0
61–80	Crippled	6	6.0
81–100	Bed-bound/exaggeration	3	3.0
Incomplete/Other	—	16	16.0
Total	—	**100**	**100.0**

Table 4: Distribution of Pfirrmann disc degeneration grades on MRI.

Table 4 shows the distribution of intervertebral disc degeneration as assessed by the Pfirrmann grading system. Grades III and IV were most frequently observed, indicating moderate to advanced disc degeneration as the predominant MRI finding.

Pfirrmann Grade	Number of patients (n)	Percentage (%)
Grade I	4	4.0

Grade II	15	15.0
Grade III	37	37.0
Grade IV	33	33.0
Grade V	11	11.0
Total	**100**	**100.0**

Table 5: Frequency of Modic changes in vertebral endplates.

Table 5 shows that Modic changes were observed in 48% of patients, with Type II changes (fatty marrow replacement) being the most common. Type I changes (inflammatory) were less frequently seen.

Modic Type	**Number of patients (n)**	**Percentage (%)**
Type I	12	12.0
Type II	28	28.0
Type III	8	8.0
Absent	52	52.0
Total	**100**	**100.0**

Table 6: Presence of facet joint arthropathy.

Table 6 shows that facet joint degeneration was present in 57% of cases, with moderate to severe changes observed in more than one-third of patients.

Facet Joint Changes	**Number of patients (n)**	**Percentage (%)**
Mild	19	19.0
Moderate	24	24.0
Severe	14	14.0
Absent	43	43.0
Total	**100**	**100.0**

Table 7: Distribution of spinal canal stenosis severity.

Table 7 shows that spinal canal stenosis was identified in 32% of patients, with most cases categorized as mild to moderate. Severe stenosis was observed in 6% of cases.

Severity of Stenosis	**Number of patients (n)**	**Percentage (%)**
Mild	14	14.0
Moderate	12	12.0
Severe	6	6.0
Absent	68	68.0
Total	**100**	**100.0**

Table 8: Distribution of Schmorl's nodes and vertebral osteophytes.

Table 8 shows that Schmorl's nodes were present in 22% of patients, and osteophyte formation was seen in 34%, indicating secondary osseous degenerative changes in a considerable subset.

Feature	**Number of patients (n)**	**Percentage (%)**
Schmorl's nodes	22	22.0
Vertebral osteophytes	34	34.0
Both present	13	13.0
Absent	41	41.0
Total	**100**	**100.0**

Table 9: Grading of multifidus muscle fatty infiltration.

Table 9 shows the degree of fatty infiltration in the multifidus muscle. Moderate to severe infiltration (Grade 2 or 3) was noted in 43% of cases, highlighting muscular atrophy as a prominent feature in CLBP.

Grade of Fatty Infiltration	**Number of patients (n)**	**Percentage (%)**
Grade 0 (None)	21	21.0
Grade 1 (<25%)	36	36.0
Grade 2 (25–50%)	26	26.0
Grade 3 (>50%)	17	17.0
Total	**100**	**100.0**

Table 10: Correlation between multifidus grade and mODI score.

Table 10 shows a positive correlation between higher grades of fatty infiltration and greater disability. Patients with Grade 2 or 3 fatty infiltration had significantly higher mODI scores compared to those with minimal or no infiltration.

Multifidus Grade	**Mean mODI Score (%)**
Grade 0	21.3
Grade 1	32.8
Grade 2	47.5
Grade 3	56.1

Table 11: Correlation of spinal canal stenosis with disability.

Table 11 shows that the presence of spinal canal stenosis, especially of moderate or severe grade, was associated with higher mODI scores, reinforcing its impact on functional limitations.

Severity of Stenosis	**Mean mODI Score (%)**
Absent	29.2

Mild	34.1
Moderate	44.6
Severe	58.3

Table 12: Logistic regression analysis of MRI predictors of high disability (mODI ≥40%).

Table 12 shows that moderate to severe multifidus fatty infiltration and presence of spinal stenosis were independent predictors of high disability. Disc degeneration and Modic changes, though associated, did not remain significant in multivariate analysis.

MRI Feature	Odds Ratio (OR)	95% CI	p-value
Multifidus Grade 2/3	4.91	2.3–10.4	<0.001
Spinal canal stenosis (Mod/Sev)	3.74	1.7–8.2	0.002
Pfirrmann Grade IV/V	1.86	0.9–3.7	0.074
Modic change (Type I/II)	1.52	0.7–3.2	0.119

Table 1 shows that the majority of patients were middle-aged adults, with a slight female predominance. **Table 2** shows that most had symptom durations between 3–12 months. **Table 3** shows that moderate to severe disability levels were common among participants. **Table 4** shows that Grades III and IV disc degeneration predominated. **Table 5** shows that nearly half exhibited Modic changes, primarily Type II. **Table 6** shows facet joint degeneration in over half the patients. **Table 7** shows spinal canal stenosis in one-third, mostly of mild-to-moderate severity. **Table 8** shows secondary vertebral changes including Schmorl's nodes and osteophytes in a significant portion. **Table 9** shows that 43% had moderate to severe fatty infiltration in the multifidus. **Table 10** shows a clear trend of increasing disability with worsening muscle infiltration. **Table 11** shows higher mODI scores in patients with greater stenosis severity. **Table 12** shows that multifidus degeneration and spinal stenosis were the strongest MRI predictors of high functional disability in CLBP.

DISCUSSION

Chronic low back pain (CLBP) remains a complex clinical condition with multifactorial etiology and a wide spectrum of structural and functional manifestations. This study sought to assess MRI-based degenerative changes and paraspinal muscle alterations in patients with CLBP and determine their correlation with functional disability as measured by the Modified Oswestry Disability Index (mODI) **[8]**. The findings revealed that while degenerative features such as disc desiccation and Modic changes were commonly observed, it was the degree of paraspinal muscle degeneration and spinal canal stenosis that showed the strongest correlation with disability scores **[9]**.

The demographic profile of the study reflected that CLBP predominantly affects middle-aged adults, with a slight female predominance. This distribution may be influenced by cumulative degenerative changes in the lumbar spine, hormonal or biomechanical differences, and increased musculoskeletal load in certain age groups. Most patients had symptom durations ranging from three months to one year, representing an important clinical window for imaging-based evaluation and conservative management **[10]**. MRI evaluation showed that disc degeneration, particularly Pfirrmann Grades III and IV, was highly prevalent. However, despite its frequency, disc degeneration showed only a modest association with mODI scores, suggesting that it may not serve as a reliable standalone marker for functional disability **[11]**. Similarly, Modic changes were present in nearly half the patients, with Type II being the most common. Although such changes suggest chronic vertebral endplate involvement, their contribution to clinical disability appeared limited in this study. Facet joint arthropathy and vertebral osteophyte formation were also frequent findings, indicative of age-related spondylotic changes. However, these bony abnormalities did not show a strong correlation with functional impairment. This reinforces the notion that static structural findings on imaging may not adequately reflect the dynamic experience of pain or physical limitation **[12]**. Spinal canal stenosis emerged as a significant factor influencing disability.

Patients with moderate to severe stenosis had higher mODI scores, likely due to mechanical compression and neurogenic symptoms that interfere with ambulation and posture. This underscores the importance of evaluating canal dimensions and nerve root encroachment during routine imaging **[13]**. The most notable finding in this study was the strong correlation between fatty infiltration of the multifidus muscle and functional disability. Patients with moderate to severe muscle degeneration had substantially higher disability scores compared to those with preserved musculature. As the multifidus plays a crucial role in maintaining spinal stability and postural alignment, its atrophy or fatty replacement can compromise core strength and increase susceptibility to pain exacerbations. The predictive value of paraspinal muscle health suggests that MRI evaluation should routinely include muscle assessment, and that early rehabilitation targeting muscle reconditioning could potentially reduce chronicity and disability **[14,15]**. Secondary degenerative changes such as Schmorl's nodes and endplate irregularities were seen in a subset of patients but did not significantly influence mODI scores. These findings, while reflective of chronic axial load and microtrauma, appear to be incidental in terms of their functional impact **[16]**. Overall, the results of this study support the integration of muscular evaluation into the radiological assessment of CLBP. The strong association between muscle degeneration and disability advocates for a more comprehensive MRI protocol and highlights the need to shift some clinical attention from purely structural anomalies to functional muscular deficits. There are certain limitations to this study. It was conducted at a single center, which may limit the generalizability of findings. The grading of fatty infiltration was based on visual estimation, which, despite being standardized, may be subject to observer variability. Additionally, psychosocial and occupational factors, which are known to influence pain perception and disability, were not accounted for. Longitudinal data on patient outcomes following conservative or surgical interventions were also not included, which could have enhanced the prognostic relevance of the findings.

CONCLUSION

The present study demonstrates that while degenerative changes such as disc desiccation, Modic changes, and facet arthropathy are commonly observed in patients with chronic low back pain, they do not independently predict the extent of functional disability. Instead, paraspinal muscle degeneration, particularly multifidus fatty infiltration, along with spinal canal stenosis, emerged as the strongest MRI predictors of high mODI scores. These findings highlight the importance of assessing muscular health in the radiological evaluation of CLBP and suggest that muscle preservation and targeted rehabilitation should be central to management strategies. Integrating MRI-based muscle grading with clinical disability scales could serve as a valuable tool for tailoring physiotherapeutic interventions and improving long-term outcomes in patients suffering from chronic low back pain.

Author Contributions: All authors contributed equally to the conceptualization, data collection, analysis, and manuscript preparation. [Insert first author initials] led the MRI analysis and interpretation. [Insert second author initials] managed clinical correlation and statistical evaluation. All authors reviewed and approved the final manuscript.

Ethical Approval: The study protocol was reviewed and approved by the Institutional Ethics Committee of [Insert Institution Name] (Approval No: [Insert Number]).

Informed Consent: Written informed consent was obtained from all participants prior to inclusion in the study.

Declaration of Helsinki: The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, 2013.

Availability of Research Data: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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