DOI: 10.37990/medr.1295316 Med Records 2023;5(3):583-6

MEDICAL RECORDS-International Medical Journal

Research Article

The Relationship between Spondylolisthesis and Modic Changes: An MRI Study

Veysel Delen[1], Alparslan Yetisgin[1], Serap Satis[1], Safiye Kafadar[2], Hamza Erdogdu[3], Saime Shermatova[2]

[1]Harran University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Şanlıurfa, Türkiye
[2]Harran University, Faculty of Medicine, Department of Radiology, Şanlıurfa, Türkiye
[3]Harran University, Faculty of Medicine, Department of Biostatistic, Şanlıurfa, Türkiye

Abstract

Aim: We aimed to investigate the relationship between the presence of spondylolisthesis and Modic changes (MCs) by using lumbar magnetic resonance imaging (MRI).

Methods: The study included 139 adult patients aged 18-65 years with lumbar spondylolisthesis detected on lumbar MRI. Demographic characteristics such as age, gender, and levels and grades of spondylolisthesis, and presence of lumbar MCs/types were recorded. The findings were compared between two groups including grade 1 and grade 2 spondylolisthesis.

Results: Grade 1 and 2 spondylolisthesis groups were similar for age (p=0.787), sex (p=0.076), listhesis' level (p=0.268) and direction (p=0.280). The presences of pars spondylolysis, disc space narrowing, and MCs were significantly higher in patients with grade 2 spondylolisthesis than those with grade 1 (94.4% vs 64.1%), (97.2% vs 83.5%), and (100% vs 83.5%), respectively (all p<0.05). Grade 2 spondylolisthesis patients had significantly higher proportion of type 2 MCs than patients with grade 1 (88.9% vs 63.1%) (p<0.05).

Conclusion: MCs are associated lumbar spondylolisthesis. The presence of spondylolisthesis may be a predisposing factor for MCs occurred in the lumbar spine. Prospective studies on the topic should be examined in more detail.

Keywords: Modic lesions, spondylolisthesis, modic changes, lumbar

INTRODUCTION

Spondylolisthesis is described as the translocation of a superior vertebral body with respect to the one subjacent (1). Lumbar spondylolisthesis is a cause of low back pain and classified into subtypes such as isthmic (spondylolitic) and degenerative. Isthmic spondylolisthesis includes pars interarticularis defect and mostly affects L5-S1 level (2). Degenerative spondylolisthesis is seen in persons over 50 and commonly affects the L4-L5 level (3). The standard grading of spondylolisthesis is based on the persentage of the translocation, and called Meyerding grading system (1). Diagnostic tools are history taking, physical exam, and radiologic evaluations by using x-ray, computerized tomography (CT), and magnetic resonance imaging (MRI) (1,2). Therapeutic approaches encompases conservative (rest, bracing, physical therapy, and analgesic drugs and applications) and surgical management (decompression, stabilization, and fusion) in resistant or advanced cases (1).

Modic changes (MCs) are bone marrow and vertebral endplate lesions visible on spinal MRI. Lumbar MCs are associated with low back pain and correlated with degenerative processes of the affected spinal segment (4,5). The classification of MCs is based on the T1 and T2 weighted images (WI) of MRI sequences, and also the histopathological meanings (5). Although the exact etiopathogenesis underlying MCs is not fully understood, segmental instability, increased mechanical loading, and degenerative immune reaction following infections in the spine are suggested mechanisms (6-9). There is no

CITATION
Delen V, Yetisgin A, Satis S, et al. The Relationship between Spondylolisthesis and Modic Changes: An MRI Study. Med Records. 2023;5(3):583-6. DOI:1037990/medr.1296861

Received: 12.05.2023 **Accepted:** 23.07.2023 **Published:** 15.08.2023
Corresponding Author: Veysel Delen, Harran University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Şanlıurfa, Türkiye
E-mail: veyseldelen@gmail.com

consensus on the best effective treatment option for MCs, but it has been found that nonoperative therapy is useful for low back pain patients with MCs (10,11).

There are some similarities between spondylolisthesis and MCs occured at the lumbar spine. For example, both the conditions are associated with low back pain and alleviated with lumbar therapies (2,11). Furthermore, both spondylolisthesis and MCs are associated with segmental instability and degenerative process in the lumbar spine (5,7). Therefore, we hypothesized that MCs may be involved to spondylolisthesis, and an increased grade of spondylolisthesis may be related to the presence of MCs in the lumbar spine. In this study, to address the presence/absence of MCs in patients with lumbar spondylolisthesis, and also to reveal the relationship between the features of the two conditions such as grade of spondylolisthesis and types of MCs were aimed. Thanks to this, if the mentioned associations can be demonstrated, the conditions' pathophysiological processes may be better understand, and thus, more appropriate protective and curative approaches may be applied more easily.

MATERIAL AND METHOD

In this study, lumbar MRI records taken on machines with 1.5T or 3T magnet power at Şanlıurfa Harran University Hospital between October 2021 and October 2022 were examined retrospectively. The MRI findings of patients with lumbar spondylolisthesis were evaluated by the same radiologist for the presence/absence of MCs, pars interarticularis defects, and intervertebral disc height at the spondylolisthesis segment. Before start the study, which was conducted in accordance with the Helsinki Declaration, approval was received from the Ethics Committee of Harran University (dated 31.11.2022 and HRU/22-21-11 number).

The Meyerding system was used for the grading of spondylolisthesis. Accordingly, grade I is 0% to 25%, grade II is 25% to 50%, grade III is 50% to 75%, grade IV is 75% to 100%, and grade V is >100% of slip (1,12).

The classification of MCs was made based on the changes in the endplate signal intensity (SI) on the T1 and T2 WI. Accordingly, type 0: no changes in the endplate SI; type I: SI is hypo on T1WI and hyper on T2WI; type II: SI is hyper on T1WI and iso or hyper on T2WI; type III: SI is hypo on both T1WI and T2WI in the endplate (5,13).

Of the 200 patients with lumbar spondylolisthesis, those between the ages of 18 and 65 years were included in this study. Those with a history of spinal surgery, fractures, tumors, infections or inflammatory rheumatological diseases, and one case with grade 4 spondylolisthesis, and also one with MCs type 3 were excluded from the study to provide homogeneity. After applying the exclusion criteria, demographic characteristics such as age and gender, the findings of MRI related to spondylolisthesis and MCs were examined and recorded in 139 patients (Figure 1).

Flow of study progress.

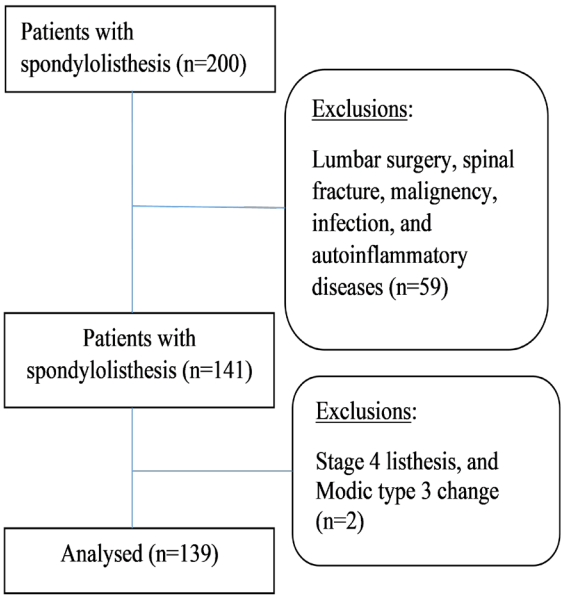

Figure 1. Flow of study progress

Statistical Analysis

Statistical analysis were performed using SPSS 20.0 for Windows (Armonk, NY: IBM Corp.). Since continuous variables had normal distribution according to the results of Kolmogorov-Smirnov test, the Student's t test was used in the statistical comparisons of age scores between the groups. Continuous data were given as mean±SD (min.-max.). Categorical variables were assessed by the Chi-Square test or Fisher's Exact test. In addition, compare column proportions with Bonferroni method by z test was used when needed. Categorical variables were given as number (percentage). Statistically significance level was considered as $p<0.05$.

RESULTS

Figure 1 schematizes the flow of progress of the study. A total of 200 patients with lumbar spondylolisthesis were assessed for eligibility. Out of the 141 patients who have eligibility criteria, 139 included in this study (n=139; 103 females, 36 males; mean age 49.83±10.14 years; range 22 to 65 years). Group 1 consisted of 103 patients with grade 1 spondylolisthesis (n=103; 72 females, 31 males; mean age 49.69±10.12 years; range 22 to 65 years). Group 2 consisted of 36 patients with grade 2 spondylolisthesis (n=36; 31 females, 5 males; mean age 50.22±10.35 years; range 24 to 65 years).

Table 1 shows the characteristics and MRI findings considering all patients.

Table 1. Characteristics and MRI findings of patients with lumbar spondylolisthesis (n=139)

	Data
Age (years)	49.83±10.14
Gender	
Female	103 (74.1)
Male	36 (25.9)
Spondylolisthesis grade	
Grade 1	103 (74.1)
Grade 2	36 (25.9)
Spondylolisthesis level	
L3-L4	13 (9.4)
L4-L5	49 (35.3)
L5-S1	77 (55.4)
Spondylolisthesis direction	
Anterior	118 (84.9)
Posterior	21 (15.1)
Pars interarticularis defect	
Yes	100 (71.9)
No	39 (28.1)
Disc space narrowing	
Yes	121 (87.1)
No	18 (12.9)
Modic change type	
Type 0	25 (18.0)
Type 1	17 (12.2)
Type 2	97 (69.8)

Data are given as mean±standard deviation or total number (%)

Table 2 shows comparisons of patients' characteristics and MRI findings considering lumbar spondylolisthesis grades. The two groups were similar for age (p=0.787), sex (p=0.076), spondylolisthesis level (p=0.268), and spondylolisthesis direction (p=0.280). The two groups were significantly different each other for the presence/absence of pars interarticularis defect (p<0.001), disc space narrowing (p=0.042), MCs (p<0.001), and for the type of MCs (p=0.003) (Table 2).

In terms of the presence of pars interarticularis defect (spondylolysis), disc space narrowing, and MCs, patients with grade 2 spondylolisthesis had significantly higher proportions than patients with grade 1 spondylolisthesis (94.4% vs 64.1%), (97.2% vs 83.5%), and (100% vs 83.5%), respectively. In terms of the type of MCs, patients with grade 2 spondylolisthesis had significantly higher proportion of type 2 of MCs than patients with grade 1 spondylolisthesis (88.9% vs 63.1%) (Table 2).

Table 2. Comparisons of patients' characteristics and MRI findings considering lumbar spondylolisthesis grades

	Spondylolisthesis grade 1 (n=103)	Spondylolisthesis grade 2 (n=36)	p
Age (years)	49.7±10.1	50.2±10.3	0.787*
Gender			0.076§
Female	72 (69.9)	31 (86.1)	
Male	31 (30.1)	5 (13.9)	
Spondylolisthesis level			0.268†
L3-L4	11 (10.7)	2 (5.6)	
L4-L5	39 (37.9)	10 (27.8)	
L5-S1	53 (51.5)	24 (66.7)	
Spondylolisthesis direction			0.280§
Anterior	85 (82.5)	33 (91.7)	
Posterior	18 (17.5)	3 (8.3)	
Pars interarticularis defect			**<0.001§**
Presence	66 (64.1)[a]	34 (94.4)[b]	
Absence	37 (35.9)[a]	2 (10.1)[b]	
Disc space narrowing			**0.042§**
Presence	86 (83.5)[a]	35 (97.2)[b]	
Absence	17 (16.5)[a]	1 (2.8)[b]	
Modic change			**<0.001§**
Presence	78 (75.7)[a]	36 (100)[b]	
Absence	25 (24.3)[a]	0 (2.8)[b]	
Modic change type			**0.003†**
Type 0	25 (24.3)[a]	0 (0)[b]	
Type 1	13 (12.6)[a]	4 (11.1)[a]	
Type 2	65 (63.1)[a]	32 (88.9)[b]	

Data are given as mean±standard deviation or total number (%); *: Student's t test; §: Fisher's Exact test; †: Chi-Square test; a, b: Compare column proportions with Bonferroni method by z test

DISCUSSION

In the present study, the findings of MCs were assessed considering lumbar spondylolisthesis grades. As result, the frequency of MCs was higher in patients with grade 2 spondylolisthesis than those with grade 1, but only type 2 MCs had higher frequency. Thus, these results suggest that increased lumbar spondylolisthesis may be involved in occured MCs, and spondylolisthesis may occurs a predisposition for development of MCs, especially for type 2 MCs.

In the previous studies, it has been shown that both spondylolisthesis and MCs occured at the lumbar spine are associated with segmental instability and sagittal imbalance (7,13). In addition, these two conditions are also associated with degenerative process in the lumbar spine

(5,7,13). Therefore, considering these common features of spondylolisthesis and MCs, it can be said that the present study is based on a sensible and scientific basis.

This study demonstrated higher proportions of spondylolysis, disc space narrowing, and MCs in patients with grade 2 spondylolisthesis compared to those with grade 1. These are not surprising results. Because spondylolysis, disc space narrowing, and MCs are degeneration-related conditions can resulted from impaired biomechanics, increased loading, and damaged anatomical structures (14-16), which are expected in the presence of spondylolisthesis. Therefore, it is logical that these conditions may be increased in patients with higher degree of spondylolisthesis than those with lesser.

According to the results of this study, patients with grade 2 spondylolisthesis had higher proportion of type 2 MCs than those with grade 1. However, grade 1 and grade 2 spondylolisthesis groups were similar to each other for the proportion of type 1 MCs. It is known that type 1 and type 2 MCs have interconvertible properties, and type 2 MCs has more stable structure (9,17). Therefore, the increased type 2 MCs seen in patients with grade 2 spondylolisthesis may be due to a conversion of type 1 and the stability of type 2 MCs. Also, type 2 MCs are more associated with overloading (18) which is possible in the presence of spondylolisthesis.

The main limitation of this study was the relatively small sample size. Since it was a retrospective study, we could not access information including the reasons for MRI, trauma histories, etiology of spondylolisthesis, duration of complaints, and body mass index. Because of certain age group in the study, the results cannot generalised to other age group. Due to no a previous study addressed MCs in patients with spondylolisthesis, a comparison with literature and an indepth discussion could not be done.

CONCLUSION

In conclusion, there is a relationship between spondylolisthesis and MCs. The presence of spondylolisthesis may be a predisposing factor for MCs occurred in the lumbar spine. In the future, with prospective studies involving multicenter and high number of MRI examinations, this issue should be examined in more detail.

Financial disclosures: *The authors declared that this study has received no financial support.*

Conflict of Interest: *The authors have no conflicts of interest to declare.*

Ethical approval: Approval was received from the Ethics Committee of Harran University (dated 31.11.2022 and HRU/22-21-11 number).

REFERENCES

1. Li N, Scofield J, Mangham P, et al. Spondylolisthesis. Orthop Rev (Pavia). 2022;14:36917.
2. Alomari S, Judy B, Sacino AN, et al. Isthmic spondylolisthesis in adults... A review of the current literature. J Clin Neurosci. 2022;101:124-30.
3. He Y, Wang W, Zhou H, et al. Imaging analysis and predictive nomogram construction for degenerative lumbar spondylolisthesis with severe clinical symptom based on propensity score matching. Sci Rep. 2023;13:4161.
4. Czaplewski LG, Rimmer O, McHale D, Laslett M. Modic changes as seen on MRI are associated with nonspecific chronic lower back pain and disability. J Orthop Surg Res. 2023;18:351.
5. Alpaycı M, Bulut MD, Yazmalar L, et al. The relationship between facet joint osteoarthritis and Modic changes of the lumbar spine: a retrospective magnetic resonance imaging study. Turk J Phys Med Rehab. 2016;62:308-13.
6. Albert HB, Kjaer P, Jensen TS, et al. Modic changes, possible causes and relation to low back pain. Med Hypotheses. 2008;70:361-8.
7. Bendersky D, Asem M, Navarrete O. Lumbar facet effusions and other degeneration parameters and its association with instability. Neurol India. 2022;70:S224-9.
8. Hayashi T, Daubs MD, Suzuki A, et al. Motion characteristics and related factors of Modic changes in the lumbar spine. J Neurosurg Spine. 2015;22:511-7.
9. Delen V, Alpayci M. Brucellosis in patients with inflammatory modic changes: results from cross-sectional and case–control comparisons. SN Compr Clin Med. 2022;4:238.
10. Mu X, Peng W, Ou Y, et al. Non-surgical therapy for the treatment of chronic low back pain in patients with Modic changes: a systematic review of the literature. Heliyon. 2022;8:e09658.
11. Issa TZ, Lambrechts MJ, Toci GR, et al. Evaluating nonoperative treatment for low back pain in the presence of modic changes: a systematic review. World Neurosurg. 2023;171:e108-19.
12. Koslosky E, Gendelberg D. Classification in brief: the meyerding classification system of spondylolisthesis. Clin Orthop Relat Res. 2020;478:1125-30.
13. Xia W, Liu C, Duan S, et al. The influence of spinal-pelvic parameters on the prevalence of endplate Modic changes in degenerative thoracolumbar/lumbar kyphosis patients. PLoS One. 2018;13:e0197470.
14. Kalichman L, Hunter DJ. Lumbar facet joint osteoarthritis: a review. Semin Arthritis Rheum. 2007;37:69-80.
15. Gellhorn AC, Katz JN, Suri P. Osteoarthritis of the spine: the facet joints. Nat Rev Rheumatol. 2013;9:216-24.
16. Fine N, Lively S, Séguin CA, et al. Intervertebral disc degeneration and osteoarthritis: a common molecular disease spectrum. Nat Rev Rheumatol. 2023;19:136-52.
17. Bråten LCH, Schistad EI, Espeland A, et al. Association of Modic change types and their short tau inversion recovery signals with clinical characteristics- a cross sectional study of chronic low back pain patients in the AIM-study. BMC Musculoskelet Disord. 2020;21:368.
18. Dudli S, Fields AJ, Samartzis D, et al. Pathobiology of Modic changes. Eur Spine J. 2016;25:3723-34.