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Lumbar vertebral magnetic resonance imaging findings in chronic low back pain: The influence of age and sex

Kronik bel ağrısında lomber manyetik rezonans görüntüleme bulguları: Yaş ve cinsiyetin etkisi

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ABSTRACT

Aim: Chronic low back pain (CLBP) is a prevalent health problem with major clinical and socioeconomic consequences. This study aimed to evaluate the frequency of lumbar vertebral magnetic resonance imaging (LVMRI) findings in CLBP patients and to analyze their associations with age and sex.

Methods: This retrospective study included 750 adults presenting with CLBP (≥3 months) to a tertiary university hospital between June and December 2024. LVMRI reports were reviewed for degenerative changes, disc herniation subtypes (bulging, protrusion, extrusion, sequestration), and nerve root compression. Findings were compared across age groups (18–40, 41–60, ≥61 years) and by sex.

Results: The patient population consisted of 69.6% females, with a median age of 45 years (IQR 34–54). Disc herniation was the most common finding (88.5%), while sequestration was the least frequent (0.7%). Degenerative changes and disc herniation significantly increased with age (p<0.001). Extrusion and sequestration showed no age–related trend. Protrusion (38.6% males vs. 29.1% females; p=0.010), extrusion (9.6% males vs. 5.2% females; p=0.022), and nerve root compression (28.9% males vs. 19% females; p=0.002) were significantly more frequent in males, whereas other degenerative features showed no sex differences. Multiple degenerative changes often coexist in the same patient.

Conclusion: LVMRI findings in CLBP increase markedly with age, while specific degenerative features such as protrusion, extrusion, and nerve root compression are more common in men. Recognizing these age– and sex–related patterns may improve diagnostic interpretation, reduce unnecessary investigations, and help tailor management strategies. This study represents the first large–scale investigation from Türkiye assessing LVMRI findings of CLBP patients according to age and sex, providing valuable epidemiological data for both clinical and radiological practice.

Keywords: Age factors; female; intervertebral disc displacement; low back pain; magnetic resonance imaging; male

Öz

Amaç: Kronik bel ağrısı (KBA) toplumda yaygın ve ciddi bir sağlık sorunudur. Bu çalışmanın amacı, KBA'lı hastalarda lomber manyetik rezonans görüntüleme (LMRG) bulgularının sıklığını belirlemek ve yaş ile cinsiyetle olan ilişkilerini incelemektir.

Yöntemler: Haziran–Aralık 2024 tarihleri arasında üçüncü basamak bir üniversite hastanesine başvuran ve ≥3 aydır KBA'sı olan 750 erişkinin LMRG raporları retrospektif olarak değerlendirildi. Dejeneratif değişiklikler, disk hernisi alt tipleri (bulging, protrüzyon, ekstrüzyon, sekestrasyon) ve sinir kökü basısı incelendi. Bulgular yaş gruplarına (18–40, 41–60, ≥61 yıl) ve cinsiyete göre karşılaştırıldı.

Bulgular: Hasta popülasyonunun %69,6'sı kadın olup medyan yaş 45 yıl (ÇAA 34–54) idi. Disk hernisi en sık (%88.5), sekestrasyon en nadir (%0.7) bulgu olarak saptandı. Dejeneratif değişiklikler ve disk hernisi sıklığı yaşla birlikte anlamlı şekilde arttı (p<0,001). Ekstrüzyon ve sekestrasyon yaşla ilişkili değildi. Protrüzyon (%38.6 erkek vs. %29.1 kadın; p=0,010), ekstrüzyon (%9.6 erkek vs. %5.2 kadın; p=0.022) ve sinir kökü basısı (%28.9 erkek vs. %19 kadın; p=0.002) erkeklerde daha sık izlendi. Buna karşın, diğer dejeneratif bulgular cinsiyete göre farklılık göstermedi. Birden fazla dejeneratif değişiklik sıklıkla aynı hastada birlikte bulundu.

Sonuç: KBA'da LMRG bulguları yaşla belirgin olarak artmakta, bazı spesifik dejeneratif özellikler ise erkeklerde daha sık görülmektedir. Bu paternlerin tanınması, klinik değerlendirmeyi kolaylaştırabilir, gereksiz tetkikleri azaltabilir ve tedaviye yönelik stratejilerin bireyselleştirilmesine katkı sağlayabilir. Bulgular, Türkiye'de KBA hastalarında yaş ve cinsiyete göre LMRG değişikliklerini inceleyen ilk büyük ölçekli çalışma olması açısından önemlidir.

Anahtar Sözcükler: Erkek; bel ağrısı; kadın; manyetik rezonans görüntüleme; vertebralar arası disk kayması; yaş faktörleri

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INTRODUCTION

Low back pain (LBP) is a prevalent health problem on a global scale. It has significant social and economic impacts. It can be defined as a combination of biophysical, psychological, and social factors that adversely affect patients' functionality, social participation, and personal financial well–being (1). LBP has been demonstrated to affect a minimum of 80% of the population at some point in their lives, irrespective of factors such as age and economic status (2). The prevalence of the condition is highest among individuals between the ages of 50 and 55, with a greater incidence observed among women (3). Based on symptom duration, LBP is commonly classified as acute (<1 month), subacute (1–3 months), or chronic (>3 months) (4). Chronic low back pain (CLBP) is defined as low back pain that persists for 3 months or more and is not caused by a clearly defined pathology such as fracture, deformity, nerve compression, infection, or neoplasm (5).

Medical imaging plays an important role in the evaluation of chronic low back pain (6). In the 2024 recommendations published by the Spine Committee of the World Federation of Neurosurgical Societies, magnetic resonance imaging (MRI) was identified as the most appropriate non–invasive method to confirm the presence of lumbar disc herniation (7). It was also emphasized that radiological imaging should be performed in patients with pain compatible with lumbar disc herniation, even in the absence of neurological deficit, in complaints that persist for 6–12 weeks (7). Furthermore, it is recommended that imaging be performed earlier in cases where motor deficits are detected (7).

Discs provide structural support to the spine by acting as a cushion against trauma between the vertebrae. A disc herniation is defined as the extrusion of the nucleus pulposus beyond the annulus fibrosus, the thick collagen ring surrounding it. The degenerative process that occurs with aging plays an important role in the development of disc pathologies by weakening the nucleus pulposus (8). Aging has been demonstrated to be associated with an increase in cellular senescence, which in turn alters cellular phenotype and extracellular matrix function (9). Congenital abnormalities, connective tissue diseases, and traumas are also implicated in the etiology of disc herniation (8). However, an increased inflammatory response has been demonstrated to induce nociceptive nerve growth into the annular nucleus pulposus, thereby contributing to the development of discogenic pain (10). LBP has been described in the literature as neuropathic, nociceptive, or neuroplastic (11).

The terms "discogenic LBP " and "axial LBP" are used to describe low back pain associated with intervertebral disc degeneration, usually without herniation, anatomical deformity, or other obvious causes of pain and disability (12). Due to biomechanical pressures, discogenic pain is more common in the lumbar vertebrae (LV) and cervical vertebrae(13).

Although degenerative changes constitute a broad conceptual framework encompassing the definitions of annular fissure, degeneration, and herniation (14), the North American Spine Society (NASS) has classified lumbar disc pathologies in meticulous detail (15). In this classification, "bulging" is defined as outward expansion beyond the edge of the ring apophyses, characterized by a circumferential size. "Protrusion," in turn, refers to a condition in which the distance between the disc material's protruding edges is smaller than the distance between the basal edges. It is usually defined as a minimal bulge. "Extrusion" signifies a condition in which the distance between the margins of the disc material is greater than the distance between the basal margins, or in which the continuity between the disc material and the disc space is lost, and refers to a more severe herniation. Finally, "sequestration" is characterized by the disc material losing all continuity with the main disc and breaking off into a free fragment. In this state, the disc material exhibits the capacity for unrestricted movement within the spinal canal. This classification system is employed to enhance comprehension and to guide the clinical management of lumbar disc pathologies (see Figure 1 for a comprehensive overview of all disc pathologies).

Each category provides essential information for both diagnosis and treatment planning (16). Disc herniations and spondylosis result in compression of the spinal nerves and subsequent compression of the roots (16). This compression of the spinal roots is the underlying cause of radicular pain that radiates along the leg (14).

To the best of our knowledge, there is no large–scale study from Türkiye that has simultaneously evaluated lumbar MRI findings of CLBP patients according to both age and sex. Therefore, our study provides novel epidemiological data and may serve as a reference for radiological practice in this population. The objective of this study was to assess the prevalence of degeneration findings in imaging results and to determine their correlation with age and

sex in patients presenting to the physical medicine and rehabilitation outpatient clinic of a tertiary hospital with a complaint of CLBP.

MATERIAL AND METHODS

Participants

This is a monocentric, non–interventional, observational study with a retrospective review of lumbar vertebrae magnetic resonance imaging (LVMRI) data. The study encompassed LVMRI data of 750 patients over the age of 18 who presented to physical medicine and rehabilitation outpatient clinics with CLBP for a minimum of three months between June 1 and December 1, 2024. Patients under 18 years of age, those with vertebral fractures, primary or metastatic vertebral neoplasia, inflammatory spondyloarthropathy, congenital structural vertebral deformities, and a spinal surgery history, were excluded from the study. The LVMRI interpretations were determined by consensus of two radiologists with a minimum of 10 years of musculoskeletal experience.

Procedure

MRI examinations of the patients were performed on a 1.5–Tesla device (Siemens Medical Systems, Germany). Sagittal plane images were obtained, encompassing the thoracic 12 at the superior level and the sacrococcygeal level at the inferior level. In the sagittal sections, images were obtained to include bilateral neural foramina at the levels included in the examination area. Images taken in the axial plane were parallel to the intervertebral disc spaces. The following types of images were obtained: T1–weighted sagittal, T2–weighted sagittal, and T2–weighted axial. T2–weighted Turbo Inversion Recovery Magnitude (TIRM) images were obtained in the coronal plane to enhance contrast resolution of the bone marrow and soft tissue.

The present study evaluated degenerative changes in the lumbar vertebrae (end-plateau changes, degenerative bone marrow changes, and osteophytic tapering of the corpus corners). To assess the degenerative signal changes in the intervertebral discs, MRI analysis was conducted using sagittal T2–weighted images. The intervertebral disc signal intensity was then categorized as follows: hyperintense appearance on T2AG (T2–weighted sequence) relative to the muscle was considered normal, isointense appearance was considered a decrease in disc signal, and hypointense appearance relative to the muscle was considered a loss of disc signal. The evaluation of intervertebral disc pathologies was conducted in accordance with the North American Spine Society (NASS) criteria (15). In cases where discal pathologies were detected, the presence of nerve root compression was evaluated using both axial and coronal sections.

Ethical considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Local Ethics Committee of Selcuk University (Decision no: 2024/580, date: 19.11.2024).

Statistical analyses

Categorical variables were presented as frequency (n), percentage (%), and continuous variables as mean, standard deviation (SD), and median values. The assumption of normal distribution of the data was checked by the Kolmogorov–Smirnov test. The relationship between age and LV degeneration findings was analyzed by Pearson chi–square test. Statistical analyses were performed using the IBM SPSS 25.0 package program (IBM Corp., Armonk, NY). p-values less than 0.05 were considered statistically significant.

RESULTS

In the present study, 750 patients were evaluated, with 522 (69.6%) identifying as female and 228 (30.4%) as male. The median age of the participants was 45 years (IQR, 34–54 years). The patients were divided into three groups: 290 (38.7%) in the 18–40 age group, 362 (48.3%) in the 41–60 age group, and 98 (13.1%) in the over 60 age group. The largest percentage of patients was observed in the 41–60 age group (48.3%). As illustrated in Table 1, the predominant imaging finding on MRI was disc herniation, while the least prevalent finding was sequestration.

Degenerative changes in the LV were detected in 463 patients (61.7%), but not in 287 patients (38.3%). Degenerative changes in the LV were detected in 58.3% of male and 63.5% of female patients. The incidence of degenerative changes by sex was not statistically significant (p=0.221). Degenerative disc changes increased proportionally with age and were statistically significant (p<0.001). The age group exhibiting the most significant decrease and loss of disc signal was between 41 and 60 years of age (see Table 3). Conversely, the loss of disc signal was least prevalent in the younger group. The de-

Table 1. The following table presents the number and percentages of findings in the lumbar vertebrae.

LVMRI Findings	Patient (n) (%)
Degeneration of the LV	463 (61.7)
Decreased disc signal	334 (44.5)
Loss of disc signal	241 (32.1)
Disc herniation	664 (88.5)
Bulging	649 (86.5)
Protrusion	240 (32.0)
Extrusion	49 (6.5)
Sequestration	5 (0.7)
Nerve root compression	165 (22.0)

LVMRI: Lumbar Vertebral Magnetic Resonance Imaging; LV: lumbar vertebrae, Values are presented as n (%). No inferential statistical test was applied in this table. n: Number, %: Percent

Table 2. The distribution of findings in the lumbar vertebrae according to sex

LVMRI Findings	Female (n) (%)	Male (n) (%)	p-value
Degeneration of the LV	330 (63.5)	133 (58.3)	p=0.221
Decreased disc signal	232 (44.4)	102 (44.7)	p=0.974
Loss of disc signal	167 (32.0)	74 (32.5)	p=0.974
Disc herniation	456 (87.4)	208 (91.2)	p=0.126
Bulging	444 (85.1)	205 (89.9)	p=0.730
Protrusion	152 (29.1)	88 (38.6)	p=0.010
Extrusion	27 (5.2)	22 (9.6)	p=0.022
Sequestration	4 (0.8)	1 (0.4)	p=0.612
Nerve root compression	99 (19.0)	66 (28.9)	p=0.002

LVMRI: Lumbar Vertebral Magnetic Resonance Imaging; LV: lumbar vertebrae. For all categorical variables in this table, Pearson's chi-square (χ^2) test was used when assumptions were met; Fisher's exact test was used when expected cell counts were low. n: Number, %: Percent.

Table 3. Distribution of findings in the lumbar vertebrae according to age groups

LVMRI Findings	18–40 years (n) (%)	41–60 years (n) (%)	61 years and older (n) (%)	p-value
Degeneration of the LV	90 (19.4)	278 (60.0)	95 (20.5)	p<0.001
Decreased disc signal	120 (35.9)	190 (56.9)	24 (7.2)	p<0.001
Loss of disc signal	33 (13.7)	134 (55.6)	74 (30.7)	p<0.001
Disc herniation	218 (32.8)	349 (52.6)	97 (14.6)	p<0.001
Bulging	205 (31.6)	347 (53.5)	97 (14.9)	p<0.001
Protrusion	73 (30.4)	119 (49.6)	48 (20.0)	p<0.001
Extrusion	19 (38.8)	23 (46.9)	7 (14.3)	p=0.961
Sequestration	1 (20.0)	2 (40.0)	2 (40.0)	p=0.190
Nerve root compression	31 (18.8)	87 (52.7)	47 (28.5)	p<0.001

LVMRI: Lumbar Vertebral Magnetic Resonance Imaging; LV: lumbar vertebrae. For all categorical variables in this table, Pearson's chi-square (χ^2) test was used when assumptions were met; Fisher's exact test was used when expected cell counts were low. n: Number, %: Percent.

crease and loss of disc signal was found to increase with age and was statistically significant (p<0.001). As demonstrated in Table 2, the distribution of disc signal change exhibited similarity across both sexes, and the rate of disc signal change by sex was not statistically significant (p=0.974).

Disc herniation was identified in 664 patients (88.5%), while it was absent in 86 patients. When the patients with disc herniation were classified according to age, disc herniation was most prevalent in the 41–60 age group and least prevalent in the 61+ age group (see Table 3). The incidence of disc herniation increased with age, a finding that was statistically significant (p<0.001). The prevalence of disc herniation varied by sex, with 91.2% of male patients and 87.4% of female patients exhibiting the condition. The distribution of disc herniation according to sex was not statistically significant (p=0.126) (Table 2).

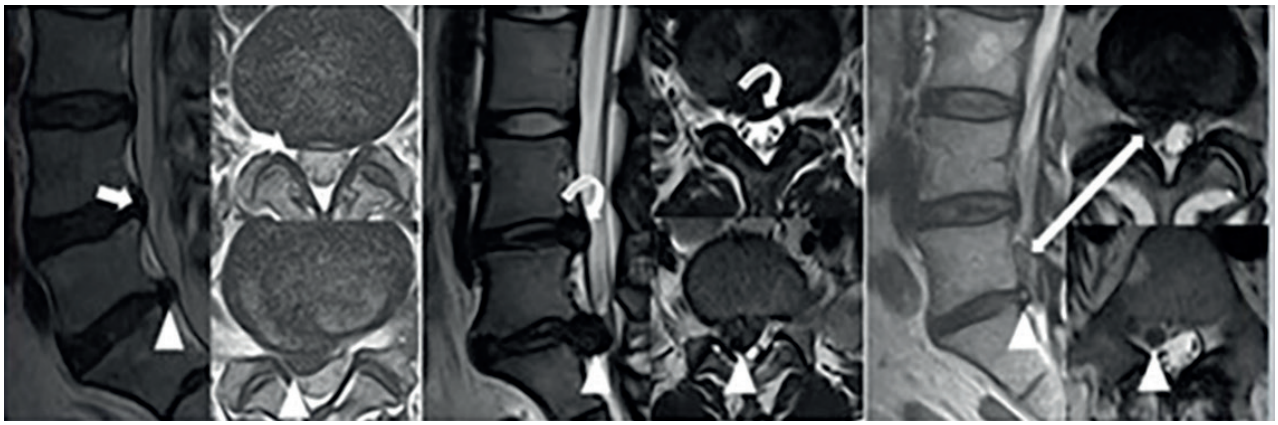


Figure 1. MRI findings of lumbar disc herniation
Diffuse disc bulging is observed at the L4–5 level, as indicated by the presence of an arrow. There is disc extrusion, which has resulted in compression of the dural sac and the right S1 nerve root at the L5–S1 level (arrowheads). Disc protrusion has been observed, resulting in compression of the dural sac at the L4–5 level (curved arrow). Additionally, there is disc sequestration migrating superiorly at the L5–S1 level, indicated by the double–headed arrow.

Diffuse bulging was the most common disc pathology (Table 1), and its incidence increased proportionally with age, which was statistically significant (p<0.001). Diffuse bulging was present in 89.9% of male patients and 85.1% of female patients, and as seen in Table 2, the incidence of bulging by sex was not statistically significant (p=0.730).

The frequency of protrusion exhibited a proportional increase with age, and the frequency of protrusion according to age was found to be statistically significant (p<0.001). While 38.6% of male patients exhibited protrusion, 29.1% of female patients did so (Table 2). The observed frequency of protrusion was higher in male patients than in female patients, and this difference was statistically significant (p=0.010).

The incidence of extrusion was observed to be uniform across all three age groups, and the incidence of extrusion according to age groups was not statistically significant (p=0.961). Extrusion was present in 9.6% of male patients and 5.2% of female patients (Table 2). The incidence of extrusion was higher in male patients than in female patients and was statistically significant. (p=0.022) The incidence of sequestration was similar in all three age groups and the incidence of sequestration according to age groups was not statistically significant (p=0.190). Sequestration was observed in 0.4% of male patients and 0.8% of female patients (Table 2). The sequestration rate according to sex was not statistically significant (p=0.612).

The incidence of nerve root compression was 18.8% in the age group 18–40 years, 52.7% in the age group 41–60 years, and 28.5% in the age group over 60 years (Table 3). Nerve root compression was present in 28.9% of male patients and 19% of female patients (Table 2). The incidence of nerve root compression was higher in male patients and statistically significant (p=0.002). Multiple degenerative abnormalities were frequently detected in the same patient.

DISCUSSION AND CONCLUSION

The present study evaluated the degeneration findings detected in LVMRIs of 750 patients admitted due to LBP in terms of age and sex. The results indicated that the age group in which degenerative changes were most prevalent was 41–60 years. Disc herniation was identified as the most prevalent degeneration finding. Findings such as protrusion, extrusion, and nerve root compression were observed more frequently in male patients; however, there was no significant difference between sexes in the frequency of other degenerative findings.

A multitude of studies conducted across various nations have investigated degenerative alterations in the LV across distinct age demographics. A study by Näther et al. evaluated the LVMRI of 200 patients, revealing that the initial symptoms of disc degeneration emerged in the 21–30 age group (17). Cheung et al. examined the prevalence of lumbar disc degeneration (LDD) within the Chinese population, revealing that individuals under 30 years of age exhibited a 40% prevalence of LDD, while the prevalence increased to over 90% among those between 50 and 55 years of age (18). A further study by Karki et al. determined that disc degeneration was more prevalent among

subjects over 40 years of age (19). In a different study by Tareq et al., it was documented that disc degenerative changes accounted for approximately 60% of all the findings and occurred primarily in the middle–aged group. This occurrence can be attributed to the fact that the aforementioned age group constituted a significant percentage of the study cohort (20). In the present study, consistent with the extant literature, the percentage of patients in the 41–60 age group was higher than in other age groups, and degenerative disc changes were most commonly observed in this age group. This phenomenon may be attributed to the prevalence of low back pain in this age group, which often leads to referral to health professionals (3).

A review of extant literature reveals a paucity of studies that have identified a statistically significant correlation between sex and vertebral degeneration (17,19,21). A systematic review by Meucci et al. concluded that vertebral degeneration is more prevalent in women. Conversely, Tareq et al. found that the LBP group exhibited a higher prevalence of degenerative findings in the male subjects within the study cohort (22). In the present study, degenerative changes in LVs were not found to be significantly associated with sex. The fact that the studies were conducted in different countries and cultures and were generally retrospective may have led to incomplete evaluation of patients in terms of social, cultural, and occupational effects. All these reasons may explain the reasons for the differences between the studies.

As shown in other studies, structural changes in the disc, expressed as a change in its signal on MRI, are the initial focus of degeneration (17,23). As reported by Al–Saeed et al., the most frequent MRI finding in symptomatic young Arab individuals was a decreased disc signal (24). In the present study, a decline in signal intensity was observed among the younger age group, with these findings being predominantly evident in the 41–60 age group. A recent cohort study revealed that signal changes in the disc did not exhibit significant differences according to sex (25). In our study, consistent with the literature, no significant association was found between disc signal changes and sex.

As stated in the relevant literature, disc herniation has been identified as one of the most prevalent degenerative changes observed in patients with LBP (26). In a study by Karki et al, herniation was found in 50% of patients (19). In another study by Brinjikji et al. it was reported that the frequency of herniation increased with age (27). In the present study, herniation was observed in 88.5% of the patients included in the study, constituting the most prevalent degenerative finding in accordance with the extant literature. The higher rate of disc herniation compared with previous studies may be attributable to our sample consisting of patients who required more advanced diagnostic evaluation from a clinical perspective. However, the rate of disc herniation observed in our study exceeded the rates reported in the extant literature. Furthermore, the incidence of herniation, bulging, and protrusion exhibited a direct proportional relationship with age in our study. A significant sex disparity was observed in the study by Karki et al., with herniation being more prevalent in male subjects than in female subjects (19). However, no significant difference was found in the distribution of disc herniation according to sex in our study. This difference in the literature may be consistent with previous studies suggesting that genetic factors play a role in the etiology of disc herniation (7). In addition, the fact that the majority of the patients in our study were women and that an equal population could not be formed may be suggested as another reason for the differences with the literature. In addition, in the study conducted by Karki et al., patients were evaluated without separation into acute and chronic and all patients were included in the study. On the other hand, the fact that only patients with CLBP were evaluated by LVMRI in our study can be considered as another possible reason for this difference.

The prevalence of disc extrusion in symptomatic populations varies between 5% and 10% (28). In our study, extrusion was detected in 6.5% of the patients, consistent with the literature. Additionally, the present study identified a higher prevalence of extruded discs among male patients compared to female patients. This sex disparity aligns with prior research suggesting that males are more susceptible to degenerative changes compared to females, potentially attributable to elevated mechanical stress and injuries (29). The higher frequency of protrusion, extrusion, and nerve root compression among males may be partly explained by greater occupational mechanical load, heavier physical activity, and cumulative biomechanical stress, although future studies are needed to confirm these hypotheses.

Sequestration was the least common degenerative finding in this study, and its distribution was not significant according to age or sex. A recent review suggested a positive correlation between the H rate of intervertebral

discs within the spinal canal and the likelihood of resorption (30). One reason why sequestrated discs were the least finding in our study may be that almost all of them (96%) resorbed spontaneously (30).

In a study by Karki et al. it was reported that nerve root compression did not show a significant difference between age groups (19). However, in our study, it was found that nerve root compression increased with age and was more common in male patients than in female patients. This may be due to increased foraminal stenosis and related nerve root compression due to degenerative changes that occur with age (16). In addition, herniated discs are one of the most common causes of nerve root compression (29). In our study, the rate of disc herniation increased with age. The increase in disc herniation with age may be a reason for the increase in nerve root compression with age. Karki et al. reported that nerve root compression was more common in men(19). In our study, nerve root compression was found to be more common in male patients in accordance with the literature.

Despite the valuable clinical insights provided by this study, several limitations must be acknowledged. The retrospective design and reliance solely on MRI findings without clinical evaluation prevented us from correlating radiological changes with symptom severity, disability indices, or functional impairment, which would have offered more comprehensive insights. In addition, this cross–sectional, single–center design limits the generalizability of the findings. Recording additional data such as symptom characteristics, lifestyle, occupational strain, and comorbidities could have allowed for a more detailed evaluation of potential confounding factors. Despite these limitations, this study represents the first large–scale investigation from Türkiye to examine lumbar MRI findings according to sex and age. Although it does not fully represent the general population since only symptomatic patients undergoing MRI were included, it provides a basic framework of morphological changes in different age groups of patients with chronic low back pain.

In conclusion, degenerative lumbar MRI findings increased with age in patients with chronic low back pain. Protrusion, extrusion, and nerve root compression were more frequent in male patients, whereas other degenerative findings showed no significant sex differences. These results demonstrate distinct age- and sex-related patterns in lumbar MRI findings in symptomatic patients.

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