THE RELATIONSHIP OF AGE AND GENDER WITH LUMBAR SPINE DEGENERATIVE CHANGES IN PATIENTS WITH LOW BACK PAIN

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ABSTRACT

Objective: Our study aimed to evaluate the prevalence of various types of degenerative changes and assess the correlation between these changes and the age, and gender of patients presenting with low back pain (LBP).

Methods: A retrospective cross-sectional observational study was carried out on individuals who presented with LBP to the Department of Radiology, Khyber Teaching Hospital Peshawar from June 2017 to May 2018 for a lumbosacral spine MRI. The sampling was done by consecutive nonprobability technique. The frequency and distribution of Pfirrman grading, Modal changes, disc herniation, and annulus tear were assessed. Furthermore, their association with the age and gender of the patient was assessed by regression analysis. SPSS 23 was utilized for conducting statistical analysis.

Results: Our study comprised 163 MRI lumbar spine patients between 30 and 90 years (mean age 46.88 with a 12.136 standard deviation). 83 patients were male (50.9%) and 80 (49.1%) were female. Age has a significant association with Pfirrman grading at L2-L3 to L5-S1 level (p-value <0.01). The percentage of degenerated segments also rose with advancing age. The greatest number of Modic changes were seen in the age range of 61-70 years (38.2%). Most annulus tears were seen at L4-L5 levels followed by L3-L4. 19% of males had annulus tears while 23.3% of females had annulus tears. The most disc bulges were observed among individuals aged 31-40 years (n=155), with the second-highest occurrence noted in the 41-50 age group (n=75).

Conclusion: Endplate changes and disc degenerative changes are associated with increasing age. Degenerative changes in the lumbar spine are not statistically different in male and female populations.

Keywords: MRI, lumbar spine, degeneration, modic changes, annulus tear, disc, age, gender.

INTRODUCTION

Low back pain (LBP) is a common contributing factor to restriction of activity and disability. Even though LBP is a vague symptom, it is crucial to confirm a diagnosis to exclude potentially serious conditions like infection, malignancy, fractures, or degenerative diseases[1]. It is a common cause for medical appointments and a prevalence of up to 85% has been reported[2]. About 12% of the population of Pakistan suffers from LBP[3]. The most frequent cause of LBP is degenerative disc disorders (82.3%)[4].

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LBP is closely linked to degenerative disc disease, encompassing a range of abnormalities like disc herniation, disc bulges, reduced disc height, disc desiccation, and other related issues.[5] Prevalence of degenerative disc disease increases with age, affecting young to middle-aged persons[3,6,7]. Lumbar disc herniation stands out as a prevalent factor contributing to LBP in adults. The herniated disc causes compression of the nerve roots, resulting in low back pain, sciatica, spasms of the muscles, and restriction of body movement[3].

A plain spine x-ray radiograph is the most frequently requested imaging investigation for LBP. These are cost-effective and easily available. However, a weak correlation between radiographic findings and LBP has been a major limitation[7,8]

Several imaging techniques can be used to investigate LBP. Due to its superior contrast resolution for soft tissues, multiplanar reconstruction capability, and lack of ionizing radiations, Magnetic Resonance Imaging (MRI) is now the preferred imaging modality [1,7]. MRI is an excellent modality for the assessment of degenerative changes in the disc.

Degenerative changes in the disc can be graded according to the Pfirrman grading system using the MRI T2W sequence[9]. On MRI the proteoglycan in the nucleus pulposus is shown as hyperintense signals on T2WI. With increasing degeneration in the disc, these high signals are lost and the difference between nucleus pulposus and annulus fibrosus cannot be made[10]

Tear can occur in the annulus fibrosus fibers. These result in fluid entering the tear which gives hyperintense signals on T2WI[11]. Modic changes are degenerations in the bone marrow of endplates of two adjacent vertebral bodies. These appear as altered signal intensity on T1W and T2W sequences of MRI[12]. Type I modic change appears as hyperintense on T2WI and hypointense on T1WI. The cause of type 1 modic change is edema of the bone marrow[13]Type II Modic changes give hyperintense signals on T1WI and T2WI and are due to fatty replacement of bone marrow. On T1WI and T2WI, type III modic changes appear hypointense and are indicative of sclerosis. [10]

Our study aims to detect a varied spectrum of degenerative spine changes in patients presenting with LBP. The height of the intervertebral disc decreases with age due to degenerative changes[14]. Few studies have evaluated the relationship of various types of degenerative changes with age and gender. This study was proposed to fill a gap in the body of knowledge by evaluating the prevalence of various types of degenerative changes. Additionally, we intend to evaluate the relationship between the degenerative changes with age and gender of patients presenting with LBP.

MATERIALS AND METHODS

163 with LBP who were referred to the Radiology Department of Khyber Teaching Hospital Peshawar from June 2017 to May 2018 for a lumbosacral spine MRI were included in this retrospective cross-sectional observational study. The patient's personal information, including name, age, gender, and comprehensive history, was collected. Lumbar spine MRI was conducted using a 1.5 T (GE) MR imager equipped with spine-phased array coils. The imaging included axial T1-weighted, T2-weighted, sagittal T1, and T2-weighted scans, each with a 4.0mm slice thickness. A field of view of 30x30mm for sagittal and coronal images and 18x18mm for axial images was employed.

The sampling was done by consecutive nonprobability technique. The sample size was determined using the formula: $n = z^2 \times p \times (1 - p) / e^2$, where *n* is the sample size, *z* is 1.96, *p* is prevalence (12% for degenerative disc disease in patients with LBP in Pakistan[4]), and *e* is the 5% error margin, with a 95% confidence interval.

$z=1.96$, $p = 0.12$, $e = 0.05$
$n = 1.96^2 \times 0.12 \times (1 - 0.12) / 0.05^2$
$n = 163$
the sample size is equal to 163

Inclusion Criteria: -Patients aged 30 to 90 with non-traumatic LBP recommended for spinal MRI.

Exclusion Criteria: Patients with recent trauma, prior lumbar spine surgery, pacemakers or metallic implants, and those whose MR findings are suggestive of infectious or neoplastic cause.

Disc degeneration of the lumbar spine was assessed by using the Pfirrman grading system[15].
Grade 1: disc is homogeneous with bright hyperintense white signal intensity and normal disc height.
Grade 2: disc is inhomogeneous but keeping the hyperintense white signal. Nucleus and annulus are clearly differentiated, and a gray horizontal band could be present.
Grade 3: disc is inhomogeneous with an intermittent gray signal intensity and distinction between nucleus and annulus is unclear. The disc height is normal or slightly decreased.
Grade 4: disc is inhomogeneous with a hypointense dark gray signal intensity. There is no more distinction between the nucleus and annulus and disc height is slightly or moderately decreased.
Grade 5: disc is inhomogeneous with a hypointense black signal intensity. There is no more difference between the nucleus and annulus and the disc space is collapsed

Modic changes were scored as 0-normal, grade I changes exhibit hyperintensity on T2-weighted images and hypointensity on T1-weighted images. Grade II demonstrates hyperintensity on both T1-weighted and T2-weighted images, while grade III presents with hypointensity on both T1-weighted and T2-weighted images. The frequency and distribution of Pfirrman grading, Modic changes, disc herniation, and annulus tear were assessed. Additionally, their association with the age and gender of patients was assessed by regression analysis. F- value of greater than 4.0 is considered statistically significant. Strength of correlation between variables was assessed by R^2 value. The greater the R^2 value(closer to 1) the better the

regression fits our observations. A statistically significant outcome was indicated by a P-value below 0.01. Software SPSS 23 was used for statistical analysis.

RESULTS

Our study comprised 163 MRI lumbar spine patients between 30 and 90 years (mean age 46.88 ± 2.136 SD presenting with LBP from June 2017 to May 2018. 83 patients were male (50.9%) and 80 (49.1%) were female.

The frequency of higher Pfirrman grades increased with increasing age. Degenerative disc with the highest prevalence of Pfirrman grade IV at the L4-L5 (n=77), and the second highest was observed at the L5-S1 (n=66). Among the degenerative disc disease grade IV was most common(n=207), followed by grade 2(n=23). Pfirrman grading for disc degeneration was regressed on age. Table 1 shows that age has a significant association with Pfirrman grading at L2-L3 to L5-S1 level(p-value <0.01). The F- value is > 4.0 but the R^2 shows a weak association. The percentage of degenerated segments rises with age, particularly affecting cranial lumbar segments with increasing age. With increasing age, most segments degenerated.

TABLE. 1: DISTRIBUTION OF PFIRRMAN GRADING AND REGRESSION ANALYSIS ON AGE.

Intervertebral disc Level	No. of disc with Pfirrman grading					P value	R^2	F
	Grade1	Grade2	Grade3	Grade4	Grade5			
L1-L2	158	0	0	5	1	0.776	.001	.81
L2-L3	137	0	0	25	5	0.000	.290	67.26
L3-L4	113	7	3	33	8	0.000	.330	79.238
L4-L5	67	9	1	78	3	0.000	.410	32.608
L5-S1	84	7	3	66	17	0.000	.189	15.744
Total	586	23	7	207	17			

The relation between gender and Pfirrman grading was also analyzed by cross-tabulation and regression analysis. No difference in disc degeneration was observed among the population of either gender (Table 2).

TABLE 2: DISTRIBUTION OF PFIRRMAN GRADING IN BOTH GENDERS.

Intervertebral disc level	Male					Female					P value
	Grade1	Grade2	Grade3	Grade4	Grade5	Grade1	Grade2	Grade3	Grade4	Grade 5	
L1-L2	78	0	0	5	0	80	0	0	0	0	0.02
L2-L3	68	0	0	15	0	69	0	0	10	1	0.492
L3-L4	56	4	3	14	4	57	3	0	19	1	0.176
L4-L5	37	1	0	38	7	31	8	1	39	1	0.02
L5-S1	46	1	0	33	3	38	6	3	33	0	0.036
Total	285	6	3	109	14	275	17	4	101	3	

Modic changes were correlated with age as shown in Table 3. Modic II changes were most common (80.4%), followed by modic type III (15%). Between the ages of 61 and 70, the greatest number of Modic changes were seen (38.2%). Modic change was regressed with age. Age is significantly associated with modic changes at L2-L3, L3-L4, L4-L5, and L5-S1(p-value <0.01), analysis of the R^2 shows weak to weak assocaition (Table 3). In contrast, no significant difference was found in either gender at all levels (Table 4).

TABLE 3: DISTRIBUTION OF MODIC CHANGES WITH AGE OF PATIENTS.

Age (years)	L1-L2			L2-L3			L3-L4			L4-L5			L5-S1		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
31-40				1			1	1			8			6	
41-50									1	3	5			3	
51-60					4			6			13	3		11	

61-70		2			9			9			13			14	
71-80					1			1			1			1	
>80											1				
P value	0.02			0.000			0.000			0.000			0.000		
R^2	0.182			0.432			0.369			0.395			0.428		
F	0.182			37.010			25.408			29.770			36.074		

TABLE 4: DISTRIBUTION OF MODIC CHANGES IN RELATION TO GENDER

Level	Male			Female			P value
	I	II	III	I	II	III	
L1-L2		2					0.258
L2-L3		9			5		0.372
L3-L4		11			6		0.332
L4-L5	3	27			14	3	0.012
L5-S1		19			16		0.398
Total (n)	3	58	0	0	41	3	

The highest number of annulus tears were observed in 31-40 years followed by 51-60 years (Table 5). No association was seen between age and annulus tear on regression analysis. Most annulus tears were seen at L4-L5 levels followed by L3-L4. 19% of males had annulus tears while 23.3% of females had annulus tears. No statistically significant difference was observed in either gender.

TABLE 5: DISTRIBUTION OF ANNULUS TEAR WITH AGE

Age (years)	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1	Total
30-40	3	4	6	10	7	30
41-50			7	13	1	21
51-60				7		7
61-70			3	2	7	12
71-80				1		1
>80						0
Total	3	4	16	33	15	71
P value	0.597	0.424	0.158	0.136	0.000	

The highest incidence of disc bulges was observed among individuals aged 31-40 years, with the subsequent highest occurrence in the 41-50 age group. The highest number of bulges were seen at L2-L3 followed by L3-L4. No significant association was established between disc bulges and gender (p value>0.01) (Table 6).

TABLE:6 DISTRIBUTION OF DISC BULGES WITH AGE

Age (years)	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1	TOTAL
31-40	**3**	**67**	**45**	**17**	**23**	**155**
41-50	**0**	**37**	**19**	**0**	**19**	**75**
51-60	**1**	**22**	**12**	**2**	**7**	**44**
61-70	**2**	**6**	**5**	**1**	**3**	**17**
71-80	**0**	**1**	**0**	**1**	**3**	**5**
>80	**0**	**0**	**0**	**0**	**1**	**1**
total	**6**	**133**	**81**	**21**	**56**	**297**
P value	**0.478**	**0.000**	**0.000**	**0.014**	**0.048**	
R^2	**0.002**	**0.233**	**0.078**	**0.028**	**0.000**	
F	**0.348**	**48.99**	**13.426**	**4.718**	**0.001**	

DISCUSSION

This cross-sectional study was conducted to assess age-related and gender-specific degenerative changes in the lumbar spine. The data gathered will assist in providing evidence for the many theories put up to explain the

pathophysiology of lumbar spine degeneration. Our main findings showed that disc degeneration and modic changes are associated with age. The frequency of Modic changes in the endplates and degeneration of the intervertebral discs tends to rise with advancing age. However, no gender-specific difference in findings was observed in the dispersion of degenerative alterations in the lumbar spine. Annulus tear and disc bulges showed no age or gender-specific distribution.

Degenerative changes in the disc occur gradually with increasing age[16,17]. There is a well-documented relation between increasing curvature of the spine, Modic changes, and degenerative changes in intervertebral disc with progression of age[18,19]. Degenerative changes in the spine are frequently identified. These include dehydrated changes in the disc, disc bulges, herniation of the disc, loss of height of the disc, and osteophyte formation[17].

The mean age of patients in our study population presenting for MRI for low back ache was about 47 years. Kohat et al conducted a study on MRI in individuals with LBP. In their research population, the average age of the patients was 41 years [20]. MRI-based meta-analysis of lumbar spine degenerative disease was done by Schroder et al[21] and Jensen et al[22] . These studies showed that degenerative changes in the female population were more prevalent above the age of 50 years. In a study by Nather et al[23] an observable rise in the occurrence of structural changes within the disc segments was noted as age advanced, and this increase exhibited statistical significance. In the elder age group, there was a higher frequency of decreased disc height. This is like findings in our study where Pfirrman grade 5 was seen in patients greater than 60 years. Comparable results were observed in the research by Wang et al[24] and Machino et al[25]. In our study degenerative disc was most found in Pfirrman grade 4, followed by grade 2. In a study conducted by Chang et al[26] Pfirrman grade 3 was common in the age range of 20 to 50 years and Pfirrman grade 4 was common in ages> 60 years. No correlation was identified between gender and degenerative alterations in the spine in our investigation. This is like the study by Nather et al[23] and Schistad et al[27]. However other studies show different results. In a study by AK Kohat et al[20] disc degeneration was more common in females, whereas in a study by Azeem et al[28], it was more common in males.

Our study evaluated the modic change distribution in the lumbar vertebrae endplates and assessed its correlation with age and gender. We found that modic type II change was most common (80.4%) followed by modic type III change (15%). This is consistent with the study by S. Jahanbakhsi et al[29]. Our study showed that age was significantly associated with modic changes at lower lumbar levels. The most common age for prevalence of modic changes in our study population was 61-70 years. It is consistent with the study by Mok et al[30] in which there was a high incidence in the 5th decade. The pathophysiology for the role of aging in Modic changes has been deduced that the water and collagen in the nucleus pulposus are decreased. This decreases the ability of the disc to absorb shock and so the spine becomes more susceptible to degeneration. Our present research shows no relation between modic changes and gender. This is contradictory to a study by Chen et al[31] in which they observed that modic type II changes were associated with the female gender. The possible reason for this may be the increased frequency of osteoporosis associated with pregnancy and multiparity[32]. However, findings like our study were seen in the study by Jahanbakhsi et al[29] where no association with gender was observed.

In our study population, we observed that the greatest number of disc bulges were seen at L2-L3, with subsequent occurrences observed at L3-L4 and L5-S1. This contradicts findings from research by Azeem et al[28] in which disc bulges were more common in lower lumbar levels. Comparable results were observed in the research by Deer et al[33]. Further study needs to be conducted to evaluate this distribution of disc bulges in our study. Furthermore, no association of disc bulges with gender was established. A higher frequency of annulus fibrosis tear was observed at L4-L5 and L5-S1 levels. However, no association was seen with age or gender. These findings were like the study by Sharma et al[34]. A study by Hadjipavlou et al[35] showed that annulus tear frequency increased with increasing age.

We analysed 163 patients with four types of degenerative changes in the lumbar spine i.e., disc degeneration, endplate changes, disc bulges, and annulus tear. We successfully collected data concerning degenerative changes in both the disc and bony structures. The association between disc and osseous degenerative changes can be studied in future studies. Our study has certain constraints, such as being conducted at a single center and having a restricted sample size. Research has been conducted to explore the association between degenerative changes in the lumbar spine and obesity, patient height, lifestyle, etc.

We were not able to collect data on these factors which can be contributing factors to degenerative changes. These modifying factors should be the subject of further study.

CONCLUSION

Degenerative changes in the lumbar spine are frequent findings encountered in MRI of patients presenting with backache. Endplate changes and disc degenerative changes are associated with the aging process. Degenerative changes in the lumbar spine are not statistically different in male and female populations.

Authors contributions

HA and MRK made significant contributions to the study's idea and design, manuscript drafting, and final approval of the version that will be published. Significant contributions to the manuscript's drafting and final version approval were made by SN, SI, and HI. Every author is committed to taking responsibility for every aspect of the research.

Conflicts of Interest

All authors declare that they have no conflicts of interest to disclose.

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