Pattern of Lumbosacral Magnetic Resonance Imaging Findings in Diagnosed Cases of Disc Degenerative Disease among Nigerian Adults with Low Back Pain

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ABSTRACT

Background: Lumbar spine disc degenerative disease (DDD) has been proven to be the most common cause of low back pain which causes musculoskeletal disability. Magnetic resonance imaging (MRI) allows detailed evaluation of all components of the lumbar spine and assesses abnormalities that may be associated with disc degeneration. **Objective:** To document the frequency of lumbosacral MRI findings in DDD with correlation to age, gender, and lumbar disc level. **Methodology:** Two hundred and eighty-one out of three hundred archived magnetic resonance images of patients aged 18 years and above investigated for low back pain at Memfys Hospital for Neurosurgery were enrolled into the study. Axial and sagittal magnetic resonance images were acquired at 5 mm slice thickness with 1 mm gap using spin echo pulse sequence. **Results:** The mean age of the study population was 55.11 years with a range of 18–91 years. Highest frequency of disc degenerative changes fell within 50–59 years age group and L4/L5 level with male preponderance. Positive findings were disc bulge 51.2%, disc protrusion 87.5%, disc extrusion 19.6%, disc sequestration 1.78%, Modic endplate changes 47.4%, Modic I 10.7%, Modic II 15.3%, and Modic III 21.4%. Logistic regression analysis showed that only posterior disc protrusion and disc bulge were significant. Odd ratio 0.062 and 0.015, respectively, while the beta values are −4.190 and −2.780, respectively. **Conclusion:** The most common lumbosacral MRI findings in diagnosed cases of DDD among patients with low back pain in this study were posterior disc protrusion, posterior disc bulge, and endplate changes.

Key words: Disc degeneration; lumbosacral spine; magnetic resonance imaging

Introduction

Upright plain radiographs in two planes are the initial screening imaging of choice for low back pain.[1] They aid in ruling out pathologies such as deformity, fracture, and metastatic tumors as underlying causes of back pain. It is supplemented by other imaging modalities for evaluation of signs of degeneration.[2] Findings in degenerative discs include disc space narrowing, endplate sclerosis, vacuum phenomenon within the disc, and osteophytes. Flexion and extension views may be helpful if instability is suspected.[1]

Magnetic resonance imaging (MRI) is a more sensitive imaging study for the evaluation of degenerative disc disease.[3] Findings on MRI scan include disc space narrowing, loss of T2 signal within the nucleus pulposus, endplate changes, and

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signs of internal disc derangement or tears.[3] High-intensity zones (HIZs) have been found in close to one-third of patients undergoing MRIs for low back pain and have been used as a marker for internal disc derangement. However, the accuracy and reliability of these HIZs have been questioned.[2,3] Modic *et al*.[4,5] were among the first to radiologically characterize vertebral endplate changes that are associated with degenerative disc disease. The Modic classification system includes three types of changes and grading which have been shown to be reliable and reproducible.[6] In Type 1, there is increased signal on T2-weighted sequence and decreased signal intensity on T1-weighted sequences indicative of marrow edema. Type 2 is characterized by fatty infiltration of the marrow as demonstrated by hyperintense T1 and T2 images. Finally, Type 3 demonstrates hypointense signals on T1 and T2 sequences, which corresponds to endplate sclerosis. The incidence of LBP has continued to increase in modern societies such as the UK, the USA, and Canada, with a reported prevalence of 39%[7] and 21%[8] in the UK and Hong Kong, respectively.

This study aims at determining the frequency of occurrence of positive MRI findings in diagnosed cases of disc degenerative disease (DDD) among adult patients presenting with low back pain, the specific objectives to be studied are the presence of disc herniation, endplate changes with Modic classification, and patients' age, gender, and affected lumbosacral disc levels.

Methodology

This was a retrospective study of the MRI lumbosacral spine images of all patients presenting with chronic low back pain at Memfys Hospital for Neurosurgery, Enugu, between January 1, 2013, and December 31, 2013. Two hundred and eighty-one cases with DDD out of three hundred patients retrieved were included in the study.

The protocol for scanning the lumbosacral spine using Basda – PI (2009) 0.35 Tesla MRI machine was used.

All patients were positioned supine on the scanning couch and a radiofrequency coil placed over patients' covering areas between the costophrenic angle and the iliac crest (region of the lumbar spine). Laser was aligned at midpoint between L1 and L3. Table was then moved under the magnet until patient was at its center.

Studies consisted of five spin echo pulse sequences:

- Coronal, sagittal, and axial localizers with a repetition time and echo time (TR/TE), field of view (FOV) of 352 cm × 352 cm
- T1-weighted sagittal images with TR/TE 400/20 ms, FOV 352 cm × 352 cm
- T1-weighted axial images with TR/TE 400/20 ms, FOV 352 cm × 352 cm
- T2-weighted sagittal images with TR/TE 3000/120 ms, FOV 352 cm × 352 cm
- T2-weighted axial images with TR/TE 3000/120 ms, FOV 352 cm × 352 cm.

A slice thickness of 5 mm with 1 mm gap was used for all sequences.

The sagittal images covered the entire width of the spine including the neural foramina. The axial images were acquired parallel to the discs and covered the adjacent margins and endplates of the adjacent vertebral bodies.

The MRI images were evaluated independently by two radiologists in a single session, and the MRI findings were entered into a predesigned data sheet. Patients' biodata including age and gender were sought from hospital records and also entered into the aforementioned data sheet. MRI images for individuals below the age of 18 years, pregnant females and those that have undergone surgical treatment for low back pain were excluded from the study.

Data analysis was done using Statistical Package for the Social Sciences (SPSS) software, IBM Corp., Released 2012, IBM SPSS Statistics for Windows, version 21.0, IBM Corp, Armonk, NY, USA.

Results

There were 281 patients with lumbar degenerative disease with a mean age of 55.1 years. Highest prevalence of the disc degenerative changes fell within the 50–59 years age group followed by 40–49 years age group [Table 1]. Furthermore, most common type of disc degenerative change was disc protrusion 87.5% (246) followed by disc bulge 51.2% (144), then endplate degenerative changes 46.70% (132) [Table 1]. There was a male preponderance of 51.25% (144) than females 48.75% (137), (0.440). Most of the MRI lumbosacral findings had higher frequency among the males [Table 2]. Multilevel involvement of disc herniation occurred in 95.37% (268) patients with L4/L5 having the highest prevalence 96.8% (272) followed by L5/S1 level 85.41% (240), whereas the least affected level is L1/L2 19.93% (56) [Table 3]. Logistic regression analysis showed that only posterior disc protrusion and disc bulge were significant, with beta values of – 4.190 and – 2.780, odd values of 0.015 and 0.062, respectively [Table 4].

Discussion

Lumbar disc degeneration is the most common cause of low back pain around the world and majority due to disc herniation.[9,10] Due to the development of MRI, noninvasive excellent imaging of spine is possible. This study revealed that there is no statistical significance between the frequency of male and female genders with lumbar disc degenerations.

Table 1: Pattern of disc degenerative changes by age

Age (in years)	Disc bulge, *n* (%)	Disc protrusion, *n* (%)	Disc extrusion, *n* (%)	Disc sequestration, *n* (%)	Endplate changes, *n* (%)	Modic 1, *n* (%)	Modic 2, *n* (%)	Modic 3, *n* (%)	Total, *n* (%)
<20	2 (0.3)	-	-	-	-	-	-	-	2 (0.3)
20-29	6 (0.8)	5 (0.7)	-	-	1 (0.1)	1 (0.1)	-	-	13 (1.8)
30-39	15 (2.1)	25 (3.5)	6 (0.8)	2 (0.3)	4 (0.6)	2 (0.3)	1 (0.1)	1 (0.1)	56 (7.8)
40-49	38 (5.3)	52 (7.3)	13 (1.8)	1 (0.1)	28 (3.9)	6 (0.8)	8 (1.1)	15 (2.1)	161 (22.6)
50-59	33 (4.6)	61 (8.5)	16 (2.2)	1 (0.1)	31 (4.3)	6 (0.8)	13 (1.8)	12 (1.7)	173 (24.2)
60-69	31 (4.3)	58 (8.1)	11 (1.5)	-	37 (5.2)	9 (1.3)	7 (1.0)	21 (2.9)	174 (24.3)
70-79	10 (1.4)	28 (3.9)	4 (0.6)	-	18 (2.5)	3 (0.4)	8 (1.1)	7 (1.0)	78 (10.9)
80 and above	9 (1.3)	17 (2.4)	5 (0.7)	2 (0.1)	13 (1.8)	3 (0.4)	5 (0.7)	4 (0.6)	58 (8.1)
Total	144	246	55	6	132	30	42	60	715

Table 2: Pattern of disc degenerative changes by gender

Disc degenerative change	Male, *n* (%)	Female, *n* (%)	Total, *n* (%)
Disc bulge	74 (51.4)	70 (48.6)	144 (100)
Disc protrusion	125 (50.8)	121 (49.2)	246 (100)
Disc extrusion	30 (54.5)	25 (45.5)	55 (100)
Disc sequestration	4 (66.7)	2 (33.3)	6 (100)
Endplate changes	66 (50.0)	66 (50.0)	132 (100)
Modic 1	22 (73.3)	8 (26.7)	30 (100)
Modic 2	22 (52.5)	20 (46.5)	42 (100)
Modic 3	22 (36.7)	38 (63.3)	60 (100)
Total	365 (51)	350 (49)	715 (100)

Table 3: Affected levels for disc herniation

End plate degenerative changes		Disc herniation	
Affected level	*n* (%)	Affected level	*n* (%)
T12	1 (0.33)		
L1	15 (5.00)	L1, L2	56 (19.93)
L2	27 (9.00)	L2, L3	117 (41.64)
L3	37 (12.33)	L3, L4	206 (73.31)
L4	62 (20.67)	L4, L5	272 (96.80)
L5	58 (19.33)	L5, S1	240 (85.41)
S1	9 (3.00)	Multi-level	268 (95.37)
Multi-level	32 (10.67)		

This differs from other studies with male predominance related to male susceptibility to disc degeneration arising from increased mechanical stress and injury.[11-17] Most cases of disc degeneration occurred in fifth and sixth decades of life which differs slightly from other studies where fourth and fifth decades were prevalent.[11,17,18] Multiplicity in the disc level involvement is common as compared to the single disc involvement, which is also concordant with the past studies.[14,15,19] The prevalence of disc herniation was highest at L4/L5 level which was concordant with findings by previous authors,[10,11,20] followed by L5/S1, then least at L1/L2. From this craniocaudal direction pattern, it can be deduced that the lower the lumbar level, the higher the prevalence of disc degenerative changes.[21,22] Most common type of disc degenerative change in this study is disc protrusion (87.5%) which is much higher than that found in some previous studies.[15,19,23,24] Disc extrusion was found in 19.5% of patients which is comparable to that by Yong *et al*.[24] (19.4%) and higher than that by Weishaupt *et al*.[23] (3.7%). Furthermore, disc bulge was found to be much higher than that by Weishaupt *et al*.[23] The differences can be attributed to only younger age group used in most of these studies.

The degenerative process within discs results in greater axial loading and increased stress on the vertebral body endplates.[25] Such changes may secondarily affect the local marrow. This study revealed that vertebral endplate changes were seen most commonly at L4 followed by L5, which was comparable to findings by Verma *et al*.[14] Kuisma *et al*.[26] found that Modic changes at L5/S1, especially Type 1 changes were common in patients with low back pain.

Distinguishing between inevitable age-related findings and degenerative findings with deleterious consequences is a challenge.[23,27] Kjaer *et al*.[27] reported that most degenerative disc abnormalities were moderately associated with low back pain. The strongest associations were noted in Modic changes and anterolisthesis. Kjaer *et al*.[28] suggested that Modic changes constitute the crucial element in the degenerative process and the disc in relation to low back pain and clinical findings. They demonstrated that DDD on its own was a fairly quite disorder, where DDD with Modic changes was much frequently associated with clinical symptoms. Most authors agree that, among Modic changes, Type 1 changes are most commonly found in patients with low back pain[14,15,26,29-32] in contrary to the finding in this study where Modic Type 3 was the most common and Type 1 the least. No definite reason was found to account for this difference. Mitral *et al*.[30] found a positive trend between the evolution of Type 1 Modic changes into Type 2 changes and the improvement of pain symptom. In addition, they observed that patients in whom Type 1 changes increased were clinically worsened.

Conclusion

In this study, the most common lumbosacral MRI findings among patients with low back pain from degenerative disc

Table 4: Logistic regression for patients with disc degeneration

	Variables in the equation							
	B	SE	Wald	df	Significant	Exp(B) OR	95% CI for Exp(B)	
							Lower	Upper
Posterior disc bulge	−2.780	0.708	15.399	1	0.000	0.062	0.015	0.249
Posterior disc protrusion	−4.190	0.756	30.712	1	0.000	0.015	0.003	0.067
Disc extrusion	−17.184	5307.830	0.000	1	0.997	0.000	0.000	
Disc sequestration	−0.214	17569.626	0.000	1	1.000	0.808	0.000	
Endplate changes affected level	−0.897	0.750	1.430	1	0.232	0.408	0.094	1.774
Constant	24.256	16,748.692	0.000	1	0.999	34,210,422,373.349		

Posterior disc bulge and posterior disc protrusion are significant, others are not. OR – Odds ratio; CI – Confidence interval; SE – Standard error

diseases are posterior disc protrusion, posterior disc bulge, and endplate changes. Posterior disc protrusion and posterior disc bulge were seen to be statistically significant.

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Conflicts of interest

There are no conflicts of interest.

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