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EVALUATION OF AGE RELATED CHANGES IN LUMBAR SPINE IN SAUDI ARABIAN ADULT POPULATION: USING MAGNETIC RESONANCE IMAGES

ALI HASSAN A. ALI[*1, 2], ABDULWAHAB A. ABUDERMAN[1] AND OMAR O.SERHAN[2]

[1]Anatomy and physiology departments, Prince Sattam Bin Abdulaziz University, Al-Kharj, KSA.
[2]Faculty of Medicine, Al-Azhar University, Cairo, Egypt.
[3]King Khalid Hospital, Al-Kharj, KSA.

ABSTRACT

The main objective of our study was to investigate the frequency of lumbar spine degeneration in subjects with low back pain using magnetic resonance images. We evaluated magnetic resonance imaging (MRI) results from 210 patients complaining low back pain for age-related degeneration in the lumbar spine. In this study, 210 adult cases ranging between 18 - 90 years of age were included. The cases were classified into 3 groups; young age group (18 - 35 years old) (66 cases), middle age group (36 - 55 years old) (75 cases) and old age group (56 - 90 years old) (69 cases).Their MRI scans were performed in the department of radiology, King Khalid Hospital, Al Kharj and studied for any age related changes. The most common feature observed in young age group was reduced disc height followed by reduced signal intensity and modic type changes. In the middle age group reduced signal intensity was the most common feature followed by modic type changes. The reduced signal intensity and modic type changes were more frequently seen in the old age group. Degenerative findings in the lumbar spine, suggesting degeneration, were common in symptomatic subjects. These results provide normative data for evaluating patients with degenerative lumbar diseases in Saudi adult symptomatic subjects.

KEYWORDS: Lumbar Spine, Age Changes, MRI.

ALI HASSAN A. ALI
Anatomy and physiology departments, Prince Sattam Bin Abdulaziz University, Al-Kharj, KSA. Faculty of Medicine, Al-Azhar University, Cairo, Egypt.

***Corresponding author**

INTRODUCTION

The lumbar spine consists of five separate vertebrae separated by intervertebral discs and reinforced by multiple ligaments and paravertebral muscles. The thecal sac containing the conus medullaris and nerve roots were located within the central vertebral canal. The nerve roots then exit the spine via the intervertebral foraminal canal obliquely instead of at right angles, which is observed in the cervical spine. Intervertebral discs have a hydrated nucleus pulposus contained within concentric rings of annulus fibrosus. With increasing age, the discs progressively dehydrate resulting in a decrease in T2 signal, which are frequently seen in asymptomatic patients[1]. Degenerative lumbar spinal disease is reported to start with the degeneration of intervertebral discs, and after a period of progression to different pathologies including herniated intervertebral discs, spinal stenosis, intervertebral instability, etc., a stable stage was reached subsequent to the formation of osteophytes[2]. The degeneration of intervertebral discs and facet joints plays an especially important role in this degenerative change in the lumbar spine[3]. Theoretically, intervertebral disc degeneration is thought to be the initial process in the typical degenerative cascade of the spine[2]. In disc degeneration, the first morphological change to occur is the separation of a segment of the cartilaginous endplate from the adjacent vertebral body; this degenerative process of the cartilaginous endplate advances after the second decade of life[4,5]. Magnetic resonance imaging utilises proton resonance technology to obtain soft tissue cross-sectional representations of the spine. The quality of these images allows the diagnostician to make more detailed and accurate assessments of the intervertebral disc and its relation to the neural structures when compared with more traditional methods, such as lumbar and computed tomography (CT) myelograms[6]. T1-weighted spin-echo (SE) images are best to evaluate the cellular content in bone marrow because of high fat content interspersed with hematopoietic elements. The hydrophobic carbon-hydrogen groups in fat result in a short T1 relaxation time because of very efficient spin-lattice relaxation[6]; conversely, water has a long T1 relaxation time[7]. Yellow marrow has signal intensity (SI) comparable with subcutaneous fat, whereas red marrow has intermediate T1 relaxation with SI lower than subcutaneous fat but higher than disk or muscle[7] Conventional T2-weighted sequences can also be helpful for evaluating bone marrow pathology. Fat protons have a relatively long T2 relaxation because of less-efficient spin-spin relaxation[6]. MRI of bone marrow has a variable appearance because of the age-related distribution of cellular and fatty marrow. Vertebral endplate (Modic) changes are bone marrow and endplate lesions visible in magnetic resonance imaging (MRI). They are shown to be associated with degenerative intervertebral disc disease. These patterns have large inter-individual variations among healthy subjects of a given age. In contrast, marrow distribution and SI patterns show little variation among each vertebral body of the same subject[8]. With advancing age, generally over age 40 years, the vertebral bone marrow becomes increasingly replaced with fatty marrow. This may occur in one of three patterns: a band like pattern of fatty replacement along the endplates, small foci of fatty marrow replacement, or larger globular areas off at replacement[9]. The most common symptom is pain although a causal relationship between patient symptoms and imaging findings is difficult given the high prevalence of degenerative disc disease findings on imaging in the asymptomatic population[10]. When advanced imaging is appropriate, magnetic resonance (MR) imaging is felt to be the ideal modality for the evaluation of low back pain because of its anatomical detail, tissue contrast, and lack of ionizing radiation[11]. MR imaging has made many advances since the beginning of its clinical use in the early 1980s, replacing many more invasive modalities. While MR imaging can accurately demonstrate the morphologic findings of degenerative disk disease, its role in providing predictive and prognostic information as well as its role in positively affecting patient outcomes in some cases was currently unclear[12]. The facet joint is a zygapo-physeal joint that is also susceptible to degenerative changes. Once there is loss of disc space height and resultant alterations in normal biomechanics, there is resultant osteophytosis and arthrosis of the facet joints. It is proposed that facet arthropathy can occur independent of the preceding degenerative changes of the intervertebral disc[13]. In addition to anatomic and morphologic accuracy, MR has allowed us to better understand the prevalence of morphologic changes associated with degenerative disease. Once that has been established, it becomes important to

understand the natural history of these findings. This information then allows us to be more accurate in assessing their prognostic value as the most important aspect of a diagnostic test is its ability to affect therapeutic management. The relationship among the vertebral body, endplate, annulus, and a disc has been studied[14-17] using degenerated and chymopapain-treated discs as models. Signal intensity changes in the vertebral body marrow adjacent to the endplates of degenerated discs are a common observation on MRI and seem to take one of three main forms. Type I changes are characterized by decreased signal intensity on T1-weighted images and increased signal on T2-weighted images. Type II changes are represented by increased signal on T1- weighted images and isointense or slightly hyperintense signal on T2-weighted images. Type III changes are represented by a decreased signal intensity on both T1- and T2-weighted images that appears to correlate with extensive bony sclerosis on plain radiographs[18]. The important ligaments of the spine include the anterior longitudinal ligament, the posterior longitudinal ligament, the paired sets of ligamentaflava (connecting the laminae of adjacent vertebrae), the intertransverse ligaments (extending between the transverse processes), and the unpaired supraspinous ligament (along the tips of the spinous processes). As these ligaments normally provide stability, any alteration in the vertebral articulations can lead to ligamentous laxity and subsequent deterioration. Loss of elastic tissue, calcification and ossification, and bone proliferation at sites of ligamentous attachment to bone are recognized manifestations of such degeneration. Common, potential complications of degenerative disc disease include alignment abnormalities, intervertebral disc displacement, and spinal stenosis. The various types of alignment abnormalities can exist alone or in combination, but the two most frequents were segmental instability and spondylolisthesis[19,20].

Aim of this work

To evaluate the frequency of age related degeneration in lumbar spine in Saudi adult subjects with low back pain using magnetic resonance images.

SUBJECTS AND METHODS

This prospective case-control study was conducted on 210 patients complaining of low back pain, who had been referred to the radiology department of King Khalid Hospital, Al Kharj for an MRI examination of the lumbar spine. In this study, 210 cases of symptomatic adults ranging between18 - 90 years of age were included. The cases were classified into 3 groups; young age group (18 - 35 years old) (66 cases), middle age group(36 - 55 years old) (75cases) and old age group (56 - 90 years old) (69 cases).The exclusion criteria included causes of the back pain such as trauma, congenital spine disorders, post-operative, infections, autoimmune disorders, and muscle spasms. Each MRI scan of the lumbar spine was performed on MRI machine (Magnetom symphony, Siemens Signa 1.5 Tesla Echo speed, Milwaukee, WI, USA) using a dedicated receive-only, spine coil. The imaging protocol included sagittal T1–Weighted Spin Echo (repetition time [TR] 700 msec/ echo time [TE] 12 msec) and T2 weighted fast spin-echo (FSE) (TR 5,000 msec/TE 130 msec) images with the following parameters: matrix = 320 × 250; field of view = 24; slice thickness 4 mm; inter-slice gap = 0.8 mm; number of excitations = 4; echo train length (ETL) = 15 and axial T2 weighted, FSE scans (TR 5000 msec/TE 72 msec; matrix 320 × 250; field view = 24 mm; inter-slice gap = 0.8 mm; number of excitations = 2; echo train length = 6). All sequences where acquired as routine with no fat saturation. The lumbar intervertebral levels evaluated were six levels from L1/L2 to L5/S1. Each level was assessed for (1) decrease in signal intensity of intervertebral disc, (2) posterior disc protrusion according to modified Matsumoto's classification[21]. End plate irrigularities, modic type changes and central and foraminal stenosis were also assessed in this study.

RESULTS

Analysis of the MRI lumbar spine made for the 210 patients, showed a high prevalence rate of degenerative changes, even though the subjects of middle age group. The majority of cases had

multiple level disease, most commonly involves the lowest 2 spine levels (L4-5 and L5-S1). Overall the L4-5 disc, whether by itself or in combination with other discs, was diseased in the majority of the patients. The various MRI features of the degenerative features in different age groups are shown in Table 1. The most common feature observed in young age group was reduced disc height followed by reduced signal intensity and modic type changes. In the middle age group reduced signal intensity was the most common feature followed by modic type changes. The reduced signal intensity and modic type changes were more frequently seen in the old age group (fig.1-fig.8). In the middle and old age groups we found some cases of spondylolisthesis.(fig.6).

Table 1

Magnetic resonance imaging features of the lumbar spine of different age group. Values are presented as number (%)

Feature	Age 18- 35 (66 cases)	Age 36- 55 (75 cases)	Age 56- 90 (69 cases)
Reduced signal intensity	20 (30%)	51 (68%)	60 (86%)
Reduced disc height	26 (39%)	42 (56%)	55 (79%)
Disc bulging	16 (24%)	30 (40%)	46 (66%)
Disc protrusion	12 (18%)	25 (33%)	42 (60%)
Disc extrusion	3(4%)	19 (25%)	38 (55%)
Endplate irregularities	19 (28%)	35 (46%)	55 (79%)
Modic type changes	22 (33%)	50 (66%)	59 (85%)
Central and foraminal stenosis	13 (19%)	39 (52%)	49 (71%)

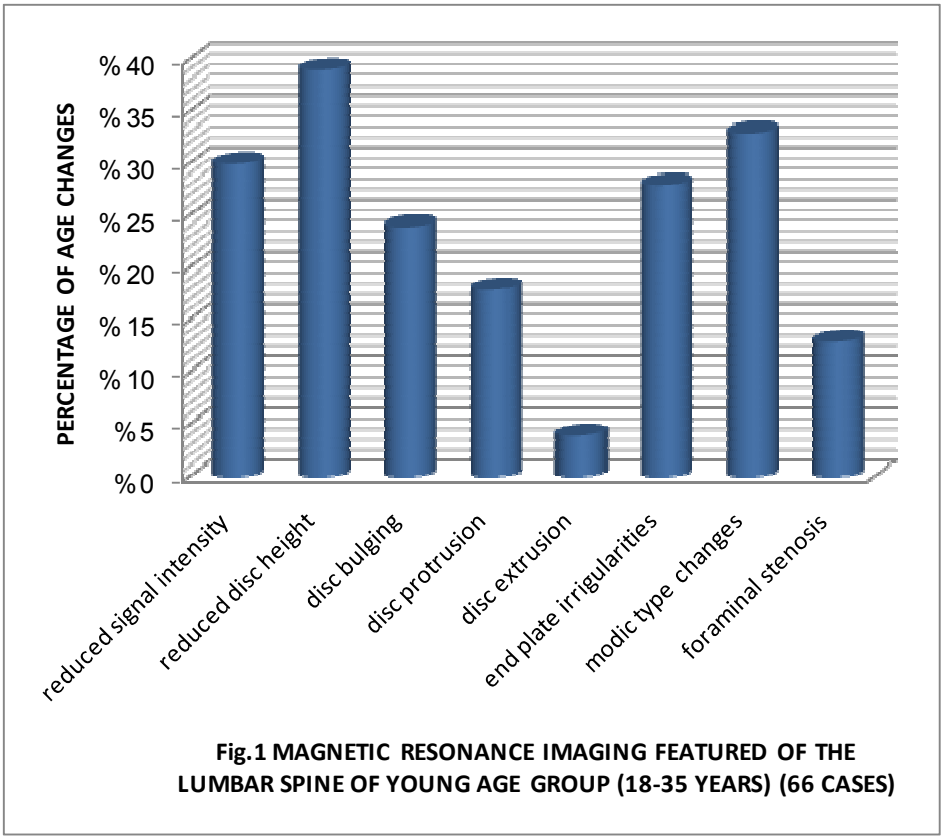

Fig.1 MAGNETIC RESONANCE IMAGING FEATURED OF THE LUMBAR SPINE OF YOUNG AGE GROUP (18-35 YEARS) (66 CASES)

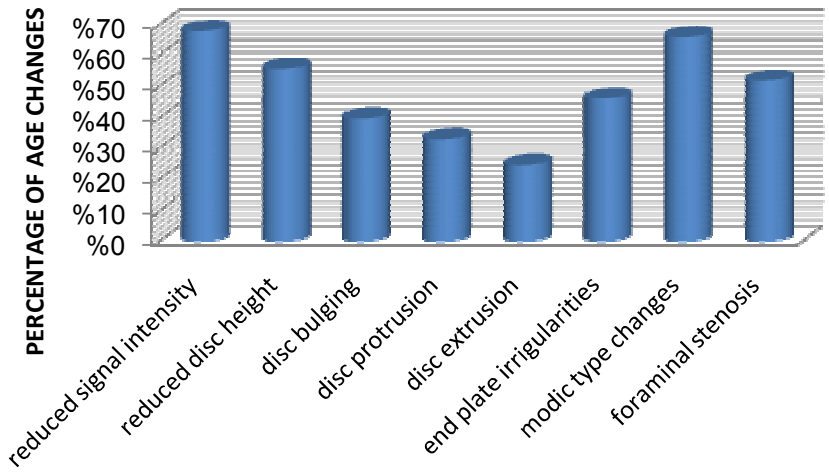

Fig.2 MAGNETIC RESONANCE IMAGING FEATURED OF THE LUMBAR SPINE OF MIDDLE AGE GROUP (36-55 … YEARS) 75

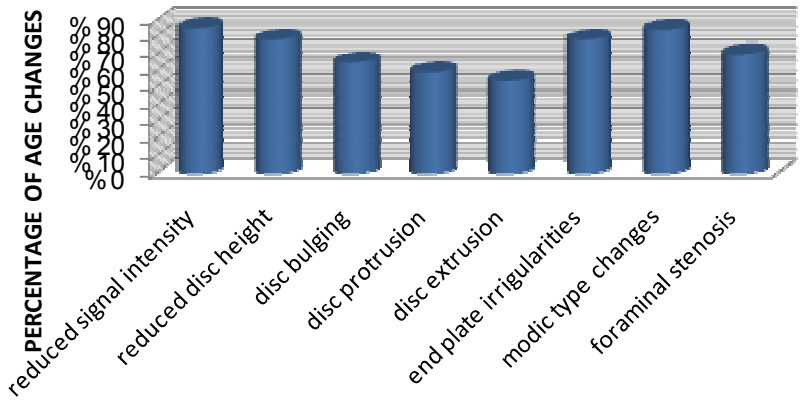

Fig. 3 MAGNETIC RESONANCE IMAGING FEATURED OF THE LUMBAR SPINE OF OLD AGE GROUP (56-90 YEARS) (69 CASES)

Figure 4
Normal Sagittal T2-weighted spin-echo MR images of the lumbar spine in a 20-year-old patient

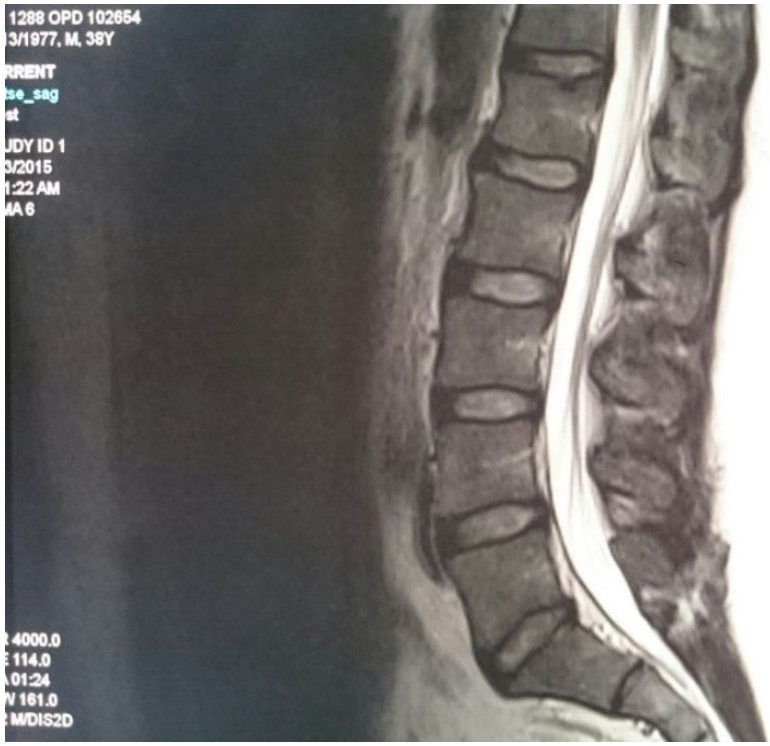

Figure 5
Lumbar spine sagittal T2WI of 38 years old male, shows decreased L5-S1 disc-space SI.

Figure 6
Sagittal T2-weighted spin-echo MR images of the lumbar spine in a 40-year-old patient demonstrate disc space narrowing , bone marrow altered signal intensity (SI) at both endplates of L5-S1. And grade one spondylolisthesis (arrow).

Figure 7
Axial T2 image 43-year-old patient demonstrate diffuse disc bulge with left exit foraminal narrowing and nerve root compression.

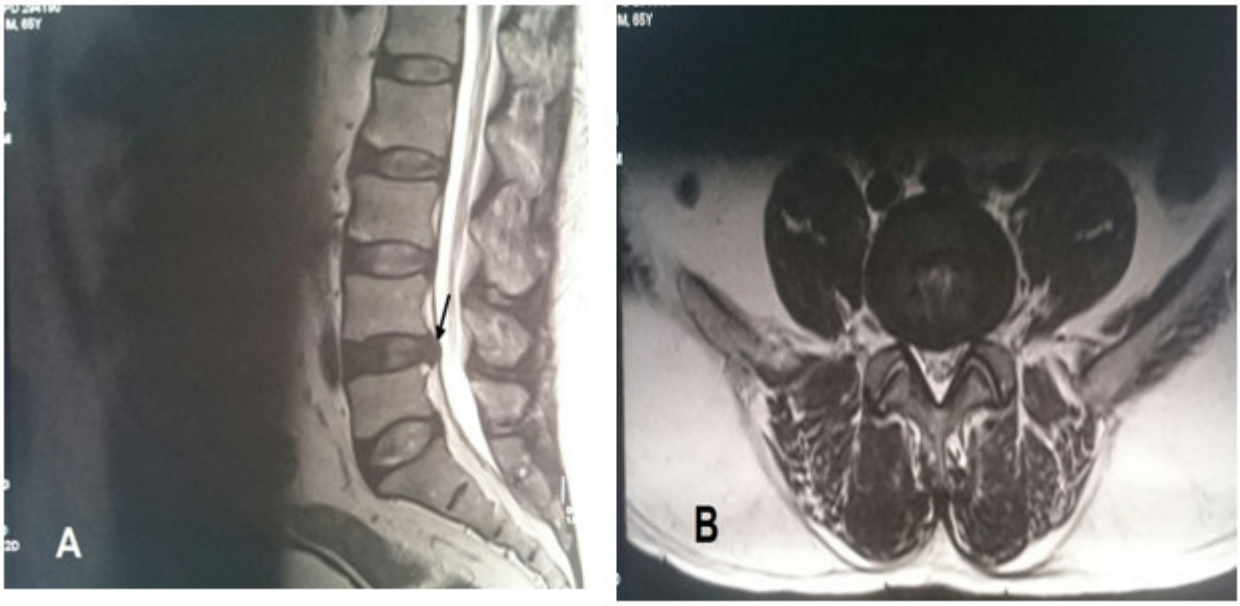

Figure 8
Sagittal (A) and Axial (B) T2 WI 65-year-old patient shows decreased SI at L4-5 disc space level and diffuse disc bulge with thecal encroachment (arrow)

DISCUSSION

This study demonstrated the frequency of positive degenerative MRI findings in the lumbar spine of Saudi Arabia adult population. There were more degenerative MRI findings in the lumbar spine in older subjects and at rostral levels such as L4–5 and L5–S1. These results nearly correspond to the results of previous studies, both with asymptomatic and symptomatic subjects[22,23]. Clearly, there are many interactive factors – mechanical, traumatic, nutritional, and genetic – all of which may play a role in the cascade of disc degeneration, albeit to variable degrees in different individuals. Whatever the etiology, by the age of 50 years, 85-95% of adults show evidence of

degenerative disc disease at autopsy [24]. On T2-weighted images, the signal intensity of the central disc is usually markedly decreased and at distinct variance to that seen in unaffected discs of the same individual. Studies using T2-weighed spin-echo sequences[25]suggested that magnetic resonance imaging (MRI) is capable of detecting changes in the nucleus pulposus and annulus fibrosus relative to degeneration and aging. This ability was based on a loss of signal presumed to be secondary to known changes of hydration that occur within the intervertebral disc. In work with cadaver spines of various ages, absolute T2 measurements correlated more closely with glycosaminoglycan (GAG) concentration than with absolute water content[26]. Thus, the signal may not be related to the total amount of water but rather to the state of the water. MR imaging can readily demonstrate morphologic alterations in the spine, however the exact meaning of those changes is not clear in some cases, which has ramifications for directing treatment, either surgical or conservative. It has been demonstrated in many different studies that there are findings of degenerative disc disease in patients who are asymptomatic. Before the advent of MR imaging, lumbar myelograms performed in asymptomatic patients were reported as showing abnormalities in 24% of normal subjects[27], and in another study, 36% of CT scans performed were abnormal with 19.5% of patients under the age of 40 and 50% of patients over the age of 40 years old showing herniated disks, facet arthropathy, or stenosis[28]. MRI studies have shown similar findings with Boden et al. describing abnormal findings on MRI examinations in asymptomatic patients in the age ranges of 20–39, 40–59, and 60–80 years at rates of 22, 22, and 57%, respectively[29]. Jensen et al. evaluated MR imaging of the lumbar spine in 98 asymptomatic individuals and found that only 36% were normal at all disc space levels. Fifty-two percent of subjects demonstrated bulging discs at one level. Overall, the degree of degenerative disc disease tended to increase with age. In asymptomatic patients, disc bulges and protrusions were present, however, disk extrusions tended not to be present[23].

CONCLUSION

Age was significantly associated with all degenerative changes. Degenerative changes in the spine were a common and natural process. This degeneration occurs gradually and can alter the stability and neurologic function of the spine.

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CONFLICT OF INTEREST

No actual or potential conflict of interest exists.

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