Original Research Article

Assessment of Degenerative Disc Diseases in the Cervical Spine through Magnetic Resonance Imaging: Insights into Age-Related Patterns and Severity

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Abstract

Introduction: The assessment of degenerative disc diseases (DDD) in the cervical spine through magnetic resonance imaging (MRI) is pivotal for understanding age-related patterns and severity. As individuals age, the cervical spine undergoes changes leading to intervertebral disc degeneration, causing pain and reduced functionality. MRI, with its detailed soft tissue imaging, offers a non-invasive means to evaluate structural alterations associated with DDD. This study explores the relationship between age and severity of cervical spine degeneration, providing insights into diagnostics and potential interventions.

Material and Methods: This descriptive study conducted at a tertiary care center aimed to evaluate and grade degenerative disc diseases in the cervical spine using Magnetic Resonance Imaging (MRI). From December 2021 to November 2022, 100 patients aged 16 years and above, presenting with neck pain and stiffness, were included. The study utilized a 1.5 Tesla MRI scanner and focused on six cervical disc levels (C1-2 to C7-D1). Exclusion criteria ensured a specific cohort, excluding those with cervical spine surgeries, spondylolisthesis, fractures, spinal cord lesions, or contraindications for MRI. Statistical analyses, including descriptive and inferential statistics, were performed using SPSS version 21.1 to assess the severity of degenerative disc diseases and explore associations with demographic factors.

Results: In our study evaluating 100 participants for degenerative disc disease in the cervical spine through MRI, we found the highest prevalence in the age groups of 21-30 years (21.0%) and 61-70 years (22.0%), with females exhibiting a higher occurrence (56%) compared to males (44%). Disc degeneration was observed at 27.0%, posterior disc protrusion at 21.0%, anterior disc protrusion at 12.0%, narrowing of disc space at 23.0%, and foraminal stenosis at 17.0%. The grading of disc degeneration across different age groups revealed a trend of increased degeneration with advancing age, with the majority observed in older age categories. Notably, Grade C2-3 posterior disc protrusions were prominent in the 21-40 and 31-40 age groups, while Grade C5-6 cases were distributed across 21-30, 41-50, and >70 years.

Conclusion: that disc degeneration was the most common degenerative disc disease, followed by posterior disc protrusion, narrowing of disc space, anterior disc protrusion, and foraminal stenosis. The C5-6 level exhibited the highest frequency of degenerative changes, with notable occurrences in the age group of 61-70 years for disc degeneration and over 70 years for posterior disc protrusion.

Keywords: Degenerative Disc Disease, Magnetic Resonance Imaging (MRI), Cervical Spine, Age-related Patterns.

Introduction

Degenerative disc diseases (DDD) of the cervical spine pose a significant healthcare challenge, contributing to pain, functional impairment, and diminished quality of life for affected individuals. [1] As a prevalent condition, the need for accurate and comprehensive diagnostic tools to evaluate and grade the severity of cervical disc degeneration becomes paramount. [2] Magnetic Resonance Imaging (MRI) has emerged as a pivotal imaging modality in this context, offering detailed anatomical visualization and non-invasive assessment of soft tissues. [3] In recent years, the role of MRI in the evaluation and grading of degenerative disc diseases in the cervical spine has

garnered increasing attention due to its ability to provide a nuanced understanding of pathological changes in intervertebral discs. [4]

The cervical spine, comprised of seven vertebrae, is particularly susceptible to degenerative changes over time. Intervertebral discs act as cushions between these vertebrae, absorbing shock and facilitating flexible movement. [5] However, aging, wear and tear, and genetic factors can contribute to the deterioration of these discs, leading to conditions such as disc bulging, herniation, and facet joint degeneration. [6] MRI, with its ability to produce detailed images of soft tissues, allows for precise visualization of these degenerative changes, aiding in the identification of specific pathologies and their impact on surrounding structures. [3]

Furthermore, the integration of advanced MRI techniques, such as diffusion-weighted imaging and magnetic resonance spectroscopy, provides additional insights into the biochemical composition and microstructural alterations within degenerating discs. [7] This not only enhances our ability to detect early degenerative changes but also offers a more comprehensive understanding of the underlying mechanisms contributing to cervical disc diseases. The significance of correlating these imaging findings with clinical symptoms cannot be overstated, as it forms the basis for developing targeted therapeutic interventions and personalized treatment plans for individuals with varying degrees of cervical disc degeneration. [8] The objectives of this study are to explore the nuances of cervical disc degeneration visible through MRI, to establish correlations between imaging findings and clinical symptoms, and to underscore the significance of MRI in guiding treatment decisions.

Material and Methods

This descriptive study was conducted at a tertiary care center from December 2021 to November 2022, with the primary objective of evaluating and grading degenerative disc diseases in the cervical spine using Magnetic Resonance Imaging (MRI). The study included a sample size of 100 patients, aged 16 years and above, who presented with complaints of neck pain and stiffness. The study population sought MRI evaluation for their symptoms, and the research was carried out at tertiary care center, Gujarat, utilizing a 1.5 Tesla MRI scanner (Philips Achieva).

The study design employed a descriptive approach, focusing on findings from patients at each cervical disc level, spanning from C1-2 to C7-D1 (a total of six disc levels). The inclusion criteria encompassed individuals aged 16 years and above, of both genders, who exhibited symptoms such as neck pain, stiffness, decreased flexibility, pain radiating to the back of the shoulder or into the arms, as well as numbness, tingling, and weakness in the arms and hands.

To ensure the specificity of the study cohort, certain exclusion criteria were established. Patients who had undergone cervical spine surgeries were excluded, along with those diagnosed with spondylolisthesis, cervical spine fractures, spinal cord lesions such as intramedullary tumors or demyelination, and individuals with other contraindications for MRI. These stringent criteria aimed to create a focused and homogeneous study population, allowing for a more accurate evaluation of the impact of degenerative disc diseases on the cervical spine in the specified patient group.

Statistical analyses were performed using software SPSS version 21.1 to quantify and interpret the data obtained from the study. Descriptive statistics, such as mean and standard deviation, were calculated to summarize the demographic characteristics of the study population. The severity of degenerative disc diseases at each cervical disc level was graded, and the distribution of these grades was presented using frequency distributions. Additionally, inferential statistics, such as chi-square tests or Fisher's exact tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables, were employed to explore potential associations between demographic factors and the severity of degeneration. A significance level of $p < 0.05$ was set to determine statistical significance.

Results

In present study, we evaluate the MRI findings of 100 participants for the occurrence of degenerative disc disease in the cervical spine across various age groups. Notably, the majority of cases are observed in the age ranges of 21-30 years (21.0%) and 61-70 years (22.0%). (Fig. 1) Degenerative disc diseases of cervical spine was more common among females (56%) followed by males (44%).
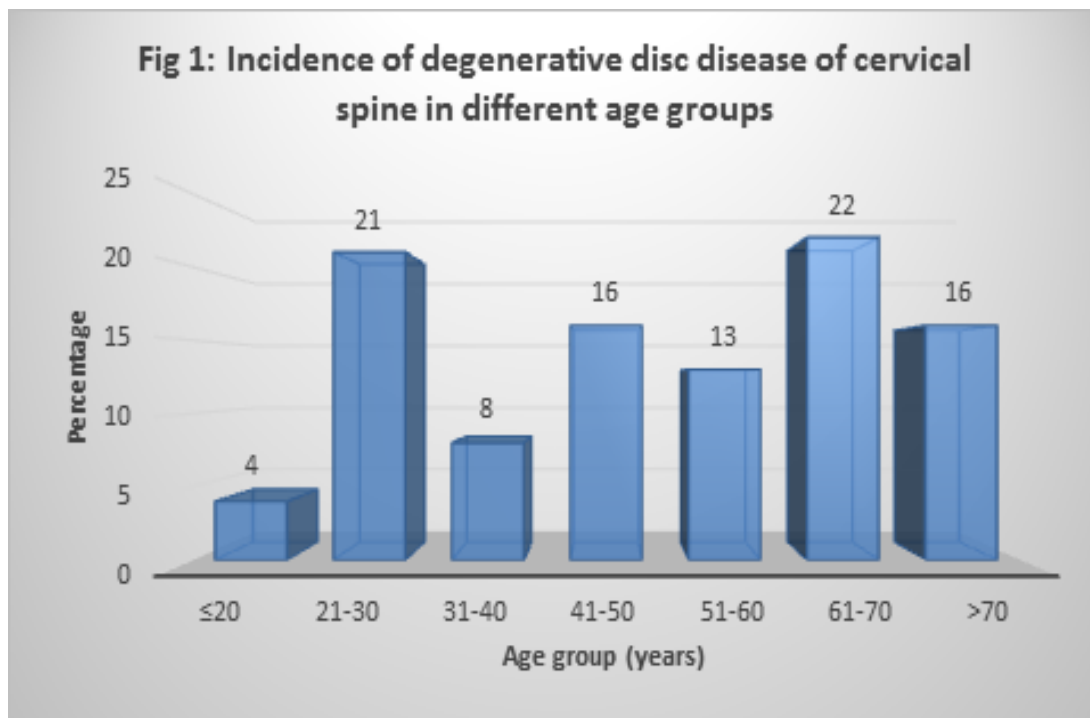
Figure 1: Incidence of degenerative disc disease of cervical spine in different age groups

Our study uses MRI to show how common degenerative disc diseases are in the cervical spine. We found that disc degeneration is at 27.0%, posterior disc protrusion at 21.0%, anterior disc protrusion at 12.0%, narrowing of disc space at 23.0%, and foraminal stenosis at 17.0%.
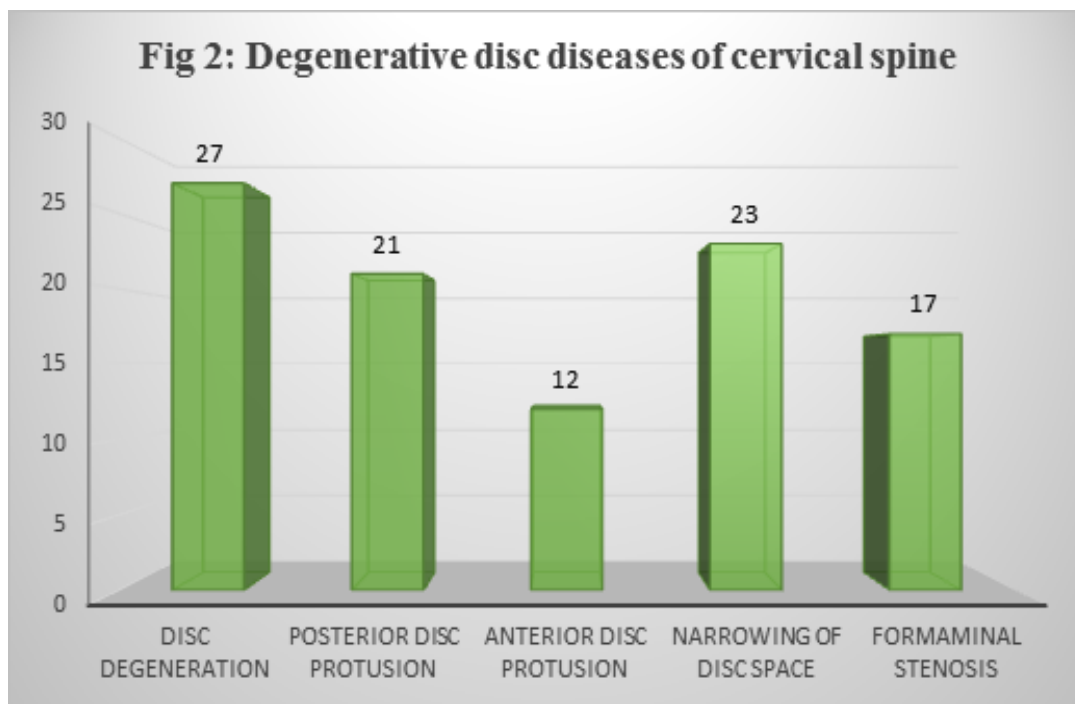

Figure 2: Degenerative disc disease of cervical spine

Table 1 illustrates the comparison of disc degeneration grading across different age groups. The grading is categorized by specific cervical disc levels (C2-3 through C6-D1), and the age distribution is segmented into intervals. Notably, the percentage distribution within each age group indicates the prevalence of disc degeneration at various cervical levels. For instance, individuals aged 61-70 exhibit a higher percentage of disc degeneration at C2-3, C3-4, and C5-6 levels compared to other age groups. The overall distribution highlights a trend of increased disc

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degeneration with advancing age, with the majority of cases observed in the older age categories. The

cervical disc degeneration was not significant at any age group in current study (p>0.05).

Table 1: Comparing grading of Disc degeneration with age distribution

Age group			Grading						
			C2-3	C3-4	C4-5	C5-6	C6-7	C6-D1	Zero
	≤20	N	0	0	0	0	0	2	2
		%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	2.7%
	21-30	N	1	0	1	1	1	1	16
		%	12.5%	0.0%	50.0%	33.3%	20.0%	25.0%	21.9%
	31-40	N	0	2	0	1	1	0	4
		%	0.0%	40.0%	0.0%	33.3%	20.0%	0.0%	5.5%
	41-50	N	1	0	1	0	1	1	12
		%	12.5%	0.0%	50.0%	0.0%	20.0%	25.0%	16.4%
	51-60	N	2	0	0	0	0	0	11
		%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.1%
	61-70	N	3	2	0	1	1	0	15
		%	37.5%	40.0%	0.0%	33.3%	20.0%	0.0%	20.5%
	>70	N	1	1	0	0	1	0	13
		%	12.5%	20.0%	0.0%	0.0%	20.0%	0.0%	17.8%
Total		N	8	5	2	3	5	4	73
		%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

In our study, the majority of Grade C2-3 posterior disc protrusions occurred in the age groups of 21-40 and 31-40 years, contributing 50% each. Notable patterns also include Grade C5-6, observed in 33.3% of patients across the age groups of 21-30, 41-50, and >70 years. In our study, the majority of Grade C2-3 cases for narrowing of disc space were in the 21-30 age group (40%), and Grade C3-4 cases were predominantly in the 21-30 age group (50%). For Grade C4-5, the majority occurred in the >70 age group (50%). Grade C5-6 cases were distributed across various age groups, and Grade C6-7 cases were mostly in the 51-60 age group (50%). In our study, Grade C2-3 formaminal stenosis predominantly occurred in the 51-60 age group (100%). Grade C3-4 cases were distributed across the age groups of 21-30, 51-60, and 61-70 (33.3% each). For Grade C4-5, the majority were in the 21-30 age group (25%). Grade C5-6 cases were spread across ≤20, 51-60, and >70 age groups (33.3% each). Grade C6-7 predominantly occurred in the 41-50 age group (66.7%). Grade C6-D1 cases were evenly split between the 41-50 and >70 age groups (50% each).

Discussion

MRI provides a noninvasive and accurate morphologic evaluation of the spine and is considered to be the most sensitive method for the assessment of disc degeneration. [9] This imaging approach provides excellent contrast evaluation for various structures, enabling the identification of conditions such as disc herniation, canal stenosis, subluxation, and malalignment. [10] Additionally, axial gradient-echo fast sequences are recommended for a complementary orthogonal plane. Multiple studies support the reliability of MRI in assessing

and grading cervical spine degenerative changes. [11] A proposed grading system by Christe et al. [12] is based on features observed in MRI, encompassing osteophytes, disc prolapse, annular tears, and signal intensity decrease. However, despite their clinical significance, reproducibility studies on grading systems for cervical intervertebral disc degeneration are limited. [13]

Our study on cervical spine degenerative disc diseases included patients aged 16 to 84, with a predominant presence in the 61-70 years age group (22%). Females accounted for 56% of cases, and males for 44%. Subgroup analysis revealed no significant sex distribution differences among age groups. Our findings align with Wang et al.'s [14] study, indicating higher frequency and severity of cervical spine degenerative changes in elderly females. Wang et al. [14] also observed a higher prevalence of spinal cord high signal in females, suggesting a susceptibility to cervical myelopathy. Concurrently, Fejer et al. [15] found that women report higher neck pain prevalence, likely influenced by both structural degeneration and physiological pain perception differences. In our study, older patients had more physical issues but fewer psychological factors contributing to disability compared to younger patients. [16]

Recent evidence, as indicated by Wang et al. [17] and Wang and Griffith [18], suggests that relative estrogen deficiency in postmenopausal women may contribute to accelerated lumbar disc degeneration and degenerative spondylolisthesis, leading to an increased prevalence of lower back pain. A similar trend may be observed in the cervical spine, as noted by Strauss et al. [19], who found disc degeneration in 17% of discs in men and 12% in women in their

twenties, rising to 86% and 89% in both men and women over 60. Gambacciani et al. [20] reported a progressive decrease in disc space after menopause, particularly within the first 5 to 10 years. However, a recent 4-year follow-up study by Wáng et al. [21] starting at a mean age of 72.5 years revealed greater lateral thoracic and lumbar disc area loss in women than in men. This aligns with previous reports by Wáng et al. [21] and de Schepper et al. [22], indicating faster disc space narrowing in women even 20 years after menopause. Importantly, this study tentatively suggests that the 'accelerated spine degeneration' phase could persist until >81 years old, representing the oldest age group in similar studies [13,14].

In our study on degenerative disc diseases of the cervical spine using MRI, disc degeneration was the most common condition (27%), followed by narrowing of disc space (23%), posterior disc protrusion (21%), anterior disc protrusion (12%), and foraminal stenosis (17%). These findings align with Okada et al.'s MRI study (2011), which revealed a higher presence of cervical disc degenerative changes in the herniation group (98.0%) compared to the control group (88.5%), even though all patients in the herniation group were asymptomatic regarding the cervical spine. The prevalence of degenerative changes increased with aging, consistent with previous reports [23–25]o. When comparing patients with lumbar disc herniation to healthy volunteers without cervical spine symptoms, the former exhibited a significantly higher prevalence of decreased signal intensity of intervertebral discs and posterior disc protrusion on cervical spine MRI. These results strongly suggest that lumbar disc herniation patients may also manifest degenerative changes in spinal segments beyond the lumbar spine, potentially influenced by individual factors such as genetics.

In our present study on cervical disc degeneration, we observed that disc degeneration was most prevalent (27%), with a notable concentration in the age group of 61-70 years (37.5%). Posterior disc protrusion was noted in 21% of discs, primarily in those over 70 years (60%). Anterior disc protrusion (12%) and narrowing of disc space (23%) showed varied age distributions, with 50% of anterior disc protrusions occurring in the 21-30 years age group and 40% of disc space narrowing observed in the 21-30 years age group. Foraminal stenosis was present in 17% of discs, exclusively in the 51-60 years age group. Our findings resonate with the literature, where disc degeneration is associated with aging, and we also confirmed that disc space narrowing represents an advanced stage of degeneration. [26,27] In terms of specific disc levels, C5-C6 exhibited the highest frequency of degenerative changes, consistent with previous studies. [28,29]

Furthermore, our study aligns with existing literature indicating the association between lumbar disc herniation and degenerative changes in the cervical spine. [30,31] This suggests a potential simultaneous occurrence of degenerative changes in both the lumbar and cervical spine, possibly influenced by individual factors such as genetics. Our observations, similar to findings by Matsumoto et al. [32] and Okada et al. [24], emphasize the need for a comprehensive examination of the entire spine in cases of disc degeneration. Notably, our study's findings on the prevalence of degenerative disc diseases are in line with recent studies, such as Parenteau et al. [33] and Suzuki et al. [34], providing additional insights into the age distribution and specific disc levels affected.

This cross-sectional study, with a small sample size and a predominantly middle-aged population, lacks a longitudinal approach to accurately depict the progression of cervical disc degeneration. The observed prevalence may not fully represent symptomatic patients in the general population, and clinical data correlating symptoms with MRI findings are absent.

Conclusion

In conclusion, our study investigated MRI findings in 100 participants, revealing a higher prevalence of cervical spine degenerative disc disease in certain age groups, with a predominant occurrence in females. The most common conditions identified were disc degeneration, narrowing of disc space, posterior disc protrusion, anterior disc protrusion, and foraminal stenosis. Notably, the C5-C6 disc level was frequently affected. The grading of disc degeneration across different age groups revealed a trend of increased degeneration with advancing age, with the majority observed in older age categories.

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