Original Article

MRI Evaluation of Cervical Intervertebral Disc Degeneration According to Age and Sex Using the Modified Pfirrmann Grading System

Udbhaw Mishra[1], Bindu Singh[2], Yogendra Singh[3], Shilpa Singh[4], Soumya Agrawal[4]

[1]Junior Resident – 3, Department of Anatomy, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India, [2]Professor and Head, Department of Anatomy, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India, [3]Associate Professor, Department of Anatomy, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India, [4]Assistant Professor, Department of Anatomy, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India.

Abstract

Background: Cervical intervertebral disc degeneration (CIDD) is a common cause of neck pain and functional disability. Increasing sedentary lifestyles, prolonged screen use, and poor posture have contributed to its growing prevalence across all age groups. Magnetic resonance imaging (MRI) provides a reliable method for assessing the severity of disc degeneration. The objective is to evaluate cervical intervertebral disc degeneration according to age and sex using the Modified Pfirrmann grading system on MRI and to determine its association with clinical symptoms. **Material and Methods:** A hospital-based comparative cross-sectional observational study was conducted on 100 adults who underwent cervical spine MRI between January 2024 and January 2026. Cervical discs from C2–C3 to C6–C7 were graded using the Modified Pfirrmann classification. Participants were grouped by age (20–29, 30–39, 40–49, 50–59, and ≥60 years) and sex. Associations between degeneration grade, demographic variables, disc level, and clinical symptoms were analyzed using Chi-square, Fisher's exact, and ANOVA tests, with $p<0.05$ considered significant. **Results:** Increasing age showed a strong positive association with higher degeneration grades ($r=0.72$, $p<0.001$). The C5–C6 level was most frequently affected, followed by C4–C5. Grade III degeneration was the commonest finding. Radiating pain, bilateral symptoms, symptom duration exceeding six weeks, and restricted neck movements were significantly associated with advanced degeneration ($p\leq0.002$). No significant association was observed between degeneration severity and sex ($p=0.214$). **Conclusion:** Cervical disc degeneration progresses with age and predominantly affects the lower cervical spine, particularly the C5–C6 level. MRI with the Modified Pfirrmann grading system offers a dependable method for evaluating degeneration severity and correlating imaging findings with clinical presentation, thereby supporting timely diagnosis and appropriate patient management.

Keywords: Cervical intervertebral disc degeneration, Magnetic resonance imaging, Modified Pfirrmann grading, Cervical spine, Neck pain, Age-related degeneration.

Received: 02 July 2026 **Revised: 20 July 2026** **Accepted: 07 August 2026** **Published: 17 August 2026**

Introduction

Cervical intervertebral disc degeneration (CIDD) is one of the leading causes of chronic neck pain and disability, affecting millions of people worldwide. Once considered a problem primarily associated with old age, it is now being increasingly diagnosed in younger adults due to changing lifestyles.[1]

Long working hours, prolonged use of computers and smartphones, poor posture, and reduced physical activity particularly during and after the COVID - 19 pandemic, have accelerated the burden of cervical spine disorders. As neck pain complaint is becoming more common in everyday clinical practice, understanding the underlying degenerative changes has become increasingly important.[2]

The cervical intervertebral disc plays a vital role in maintaining spinal stability while allowing the neck its remarkable range of motion.[3] However, with advancing age and repeated mechanical stress, the disc gradually loses its water content and elasticity, leading to structural changes such as disc bulging, reduced disc height, osteophyte formation, and, in advanced cases, compression of neural structures. Although aging is the strongest risk factor, degeneration is also influenced by gender, occupation, genetics, obesity, smoking, and lifestyle habits.[4]

It has been seen that Magnetic resonance imaging (MRI) is the most reliable imaging modality for detecting these changes because it provides excellent visualization of both early and advanced disc pathology.[5] Despite the growing burden of cervical disc degeneration, Indian data describing its age and gender related patterns remain limited.[6]

The present study was therefore undertaken to evaluate cervical disc degeneration using MRI across different age groups and

Address for correspondence: Dr. Bindu Singh, Professor and Head, Department of Anatomy, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India.
E-mail: bindusingh10@gmail.com

DOI:
10.21276/amit.2026.v13.i2.944

How to cite this article: Mishra U, Singh B, Singh Y, Singh S, Agrawal S. MRI Evaluation of Cervical Intervertebral Disc Degeneration According to Age and Sex Using the Modified Pfirrmann Grading System. Acta Med Int. 2026;13(2):1716-1721.

between sexes, with the aim of generating evidence that may support earlier diagnosis, better risk assessment, and more effective preventive and therapeutic strategies.

Materials and Methods

Study Sample and Setting: This hospital based comparative cross-sectional observational study was conducted in the Departments of Anatomy and Radiodiagnosis, Baba Raghav Das Medical College, Gorakhpur, India, from January 2024 to January 2026. After obtaining Institutional Ethics Committee approval and written informed consent, 100 consecutive adults undergoing cervical spine MRI for non-traumatic indications were enrolled. Participants were categorized into five age groups (20 - 29, 30 - 39, 40 - 49, 50 - 59, and ≥ 60 years) to evaluate age and gender related variations in diffuse cervical disc bulge.

Inclusion and Exclusion Criteria

Adults with complete and interpretable cervical spine MRI examinations extending from C2 - C3 to C6 - C7 were eligible for inclusion. Individuals with previous cervical spine surgery, traumatic cervical injuries, congenital spinal anomalies, spinal infections, poor-quality MRI scans, or contraindications to MRI were excluded from the study.

MRI Parameters: MRI examinations were performed using a 1.5 - Tesla scanner with a dedicated cervical spine coil. Each cervical intervertebral disc from C2 - C3 to C6 - C7 was evaluated on sagittal and axial magnetic resonance imaging (MRI). Diffuse disc bulge was defined as a circumferential extension of disc tissue beyond the margins of the adjacent vertebral body involving more than 25% of the disc circumference while maintaining an intact annulus fibrosus. The following parameters were recorded for each participant: All MRI scans were independently reviewed by two experienced radiologists who were blinded to the participants' demographic and clinical details.

The parameters recorded were :

1. Age group (20 - 29, 30 - 39, 40 - 49, 50 - 59, and ≥ 60 years).
2. Sex (male or female).
3. Cervical intervertebral disc level involved (C2 - C3 to C6–C7).
4. Pattern of disc involvement (single level or multilevel).
5. Modified Pfirrmann grade (Grades I–V) for each cervical intervertebral disc.
6. Clinical characteristics, including:
   a) Type of pain (radiating or non-radiating).
   b) Pain laterality (unilateral or bilateral).
   c) Duration of symptoms (<6 weeks or >6 weeks).
   d) Neck movement (normal or restricted).

Assessment of Disc Degeneration

The severity of cervical intervertebral disc degeneration was evaluated using the Modified Pfirrmann Grading System8 on mid sagittal T2 weighted MRI images. Grading was based on four morphological parameters:

1. Disc signal intensity.
2. Distinction between the nucleus pulposus and annulus fibrosus.
3. Intervertebral disc height.
4. Overall disc morphology (structural changes).

Based on these imaging characteristics, each disc was classified into one of five grades:

1. Grade I: Normal, well-hydrated disc with homogeneous hyperintense signal, clear nucleus-annulus distinction, and normal disc height.
2. Grade II: Mild degeneration with slight inhomogeneity of signal and preserved disc height.
3. Grade III: Moderate degeneration characterized by intermediate signal intensity, indistinct nucleus-annulus differentiation, and mild reduction in disc height.
4. Grade IV: Advanced degeneration with hypointense signal, loss of normal disc architecture, and moderate reduction in disc height.
5. Grade V: End-stage degeneration with marked hypo intensity, collapse of disc height, and severe structural changes.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 30.0. Categorical variables were expressed as frequencies and percentages. Associations between Modified Pfirrmann grade of cervical disc degeneration and age group and sex were analyzed using the Chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

Results

Figure 1: Sagittal T2-weighted cervical MR imaging of a 64 year old patient patient. Pfirrmann classifications of the cervical discs were as follows: C2 - 3 is Grade 2, C3 - 4 is Grade 3, C4 - 5 is Grade 3, C5 - 6 is 4, C6 - 7 is Grade 5

Figure 2: Grade 1 Pfirmann Degeneration

Figure 4: Grade 3 Pfirmann Degeneration

Figure 3: Grade 2 Pfirmann Degeneration

Figure 5: Grade 4/5 Pfirmann Degeneration Degeneration.

Table 1: Gender wise distribution of the study participants.

Age Group (years)	Male	Female	Total	Mean Age (years ± SD)
20–29	10	5	15	24.8 ± 2.1
30–39	18	10	28	35.1 ± 3.4
40–49	17	8	25	44.2 ± 3.1
50–59	13	6	19	54.6 ± 4.0
≥60	6	7	13	65.8 ± 3.8
Total	64	36	100	—

Table 2: Distribution of clinical symptoms among subjects

Sl. No.	Clinical Symptom	Category	Number of Cases (n)	Percentage (%)
1.	Pain	Radiating pain	76	76%
		Non - radiating pain	24	24%
2.	Pain Laterality	Bilateral	59	59%
		Unilateral	41	41%
3.	Duration of Symptoms	> 6 weeks	72	72%
		< 6 weeks	28	28%
4.	Neck Movement	Restricted	20	20%
		Normal	80	80%

Table 3: Distribution of cervical disc degeneration

Disc Level	Grade I	Grade II	Grade III	Grade IV/V	Total (n)
C2–C3	12	10	4	2	28
C3–C4	10	12	8	5	35

C4–C5	8	13	12	6	39
C5–C6	5	10	18	10	43
C6–C7	3	6	16	9	34
Total	38	51	58	32	179 Discs*

Table 4: Age and gender wise distribution of cervical disc degeneration according to Pfirrmann grades (I - V)

Age Group (years)	Gender	Grade I	Grade II	Grade III	Grade IV/V	Total (n)
20–29	Male	6	4	0	0	10
	Female	3	2	0	0	5
30–39	Male	5	8	5	0	18
	Female	3	5	2	0	10
40–49	Male	1	4	7	5	17
	Female	0	2	5	1	8
50–59	Male	0	2	7	4	13
	Female	0	1	3	2	6
≥ 60	Male	0	0	3	3	6
	Female	0	0	4	3	7
Total		18	28	36	18	100

Table 5: Relationship between clinical symptoms and Pfirrmann grades in cervical disc degeneration

No.	Symptom	Category	p-value	Statistical significance
1.	Pain	Radiating pain	<0.001	Highly significant
2.	Pain laterality	Bilateral	<0.001	Highly significant
3.	Duration	> 6 weeks	0.002	Significant
4.	Neck movement	Restricted	0.001	Significant

Table 6: Relationship of age, gender, level of disc involved with Pfirrmann grades in cervical disc degeneration

Comparison	Test Used	p-value	Significance
Age group	ANOVA	< 0.001	Highly significant
Age	(r)	0.72	Highly Significant
Gender	Chi-square	0.214	Not significant
Level of disc involvement	Chi-square	0.031	Significant

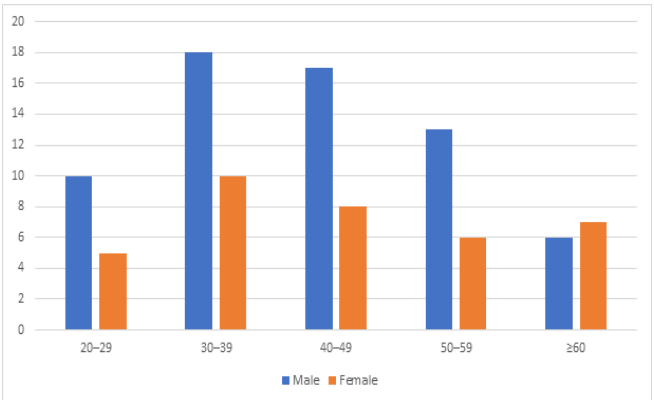

Figure 6: Gender wise distribution of the study participants.

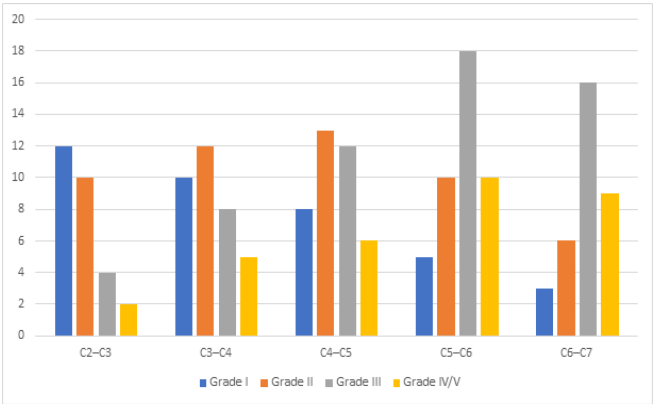

Figure 7: Bar Distribution of cervical disc degeneration

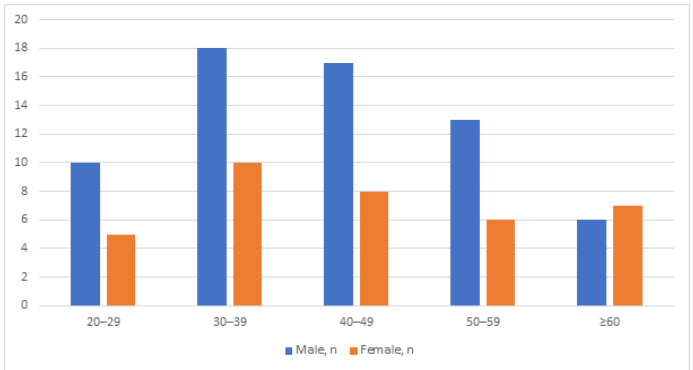

Figure 8: Bar Distribution of age and gender wise distribution of cervical disc degeneration according to Pfirrmann grades (I - V)

Discussion

The present study evaluated cervical intervertebral disc degeneration in 100 symptomatic patients using the Modified Pfirrmann grading system and demonstrated that degeneration severity was significantly associated with advancing age ($r = 0.72$, $p < 0.001$), cervical disc level ($p = 0.031$), and clinical presentation, whereas no significant association was observed with gender ($p = 0.214$). These findings support the concept that cervical disc degeneration is a progressive age-related process with a characteristic distribution in the lower cervical spine.

Age was the strongest determinant of cervical disc degeneration in the present study. Lower Pfirrmann grades predominated in younger individuals, while Grades III and IV/V were increasingly observed with advancing age. Similar observations

were reported by Suzuki et al,[8] who evaluated 1,059 symptomatic patients (6,354 cervical discs) and demonstrated a significant positive correlation between age and cervical disc degeneration ($R = 0.603$, $P < 0.01$), with the average number of degenerated levels increasing from 0.7 in patients in their twenties to 3.5 in those in their seventies. Likewise, Matsumoto et al,[9] reported age related progression of degeneration in 497 asymptomatic subjects, with disc degeneration increasing from 17% in men and 12% in women in their twenties to 86% and 89%, respectively, in individuals over 60 years of age. Similarly, Xiao - Rong Wang et al,[10] observed that 98.1% of 422 elderly subjects exhibited at least one cervical degenerative change, confirming that degeneration continues to increase even in advanced age.

The present study identified 179 degenerated cervical discs, with C5 - C6 (43 discs) being the most frequently involved level, followed by C4 - C5 (39 discs), C3 - C4 (35 discs), C6 - C7 (34 discs), and C2–C3 (28 discs). Grade III degeneration was the most common finding (58 discs), followed by Grade II (51 discs), Grade I (38 discs), and Grade IV/V (32 discs). This lower cervical predominance is comparable with Suzuki et al,[8] who found C5 - C6 to be the most frequently affected level (51.2%) followed by C4 - C5 (19.8%) and C6 - C7 (16.7%), with degeneration predominantly occurring in contiguous segments. Matsumoto et al9. and Xiao - Rong Wang et al,[10] also identified C5 - C6 as the level most susceptible to degenerative changes, reflecting the greater biomechanical stress and mobility of the lower cervical spine.

Although males constituted 64% of the study population, gender was not significantly associated with degeneration severity ($p = 0.214$). In contrast, Xiao - Rong Wang et al10. reported that degenerative changes were generally more prevalent and severe among elderly females, while Karki et al,[11] observed that disc degeneration and disc bulge occurred more frequently in patients older than 40 years, irrespective of sex, emphasizing the dominant influence of ageing on cervical degeneration.

Clinical symptoms correlated significantly with MRI findings in the present study. Radiating pain (76%), bilateral symptoms (59%), symptom duration >6 weeks (72%), and restricted neck movement (20%) were significantly associated with higher Modified Pfirrmann grades. These findings agree with Maurya RK et al., who demonstrated a close relationship between MRI detected degeneration and symptom severity, and with Karki et al,[11] who reviewed 750 cervical MRI examinations and found cervical degenerative pathology in 571 patients (76.13%), with disc degeneration and disc bulge being the most common abnormalities and increasing in frequency after the age of 40 years.

Overall, the present study confirms that cervical intervertebral disc degeneration progresses with advancing age, predominantly affects the C5 - C6 level, and is closely associated with clinical symptoms. The Modified Pfirrmann grading system provided a reliable MRI based method for assessing degeneration severity and may be useful for correlating radiological findings with clinical presentation and guiding patient management.

Conclusion

Cervical intervertebral disc degeneration is a multifactorial, progressive process that increases with advancing age and predominantly involves the lower cervical spine, especially the C5–C6 level. The present study demonstrates a strong association between degeneration severity and age, cervical level, and clinical symptoms, while gender showed no significant influence. MRI, combined with the Modified Pfirrmann grading system, reliably identified degenerative, morphometric, and ligamentous changes, enabling meaningful clinicoradiological correlation. These findings emphasize the pivotal role of MRI in the early detection, objective assessment, and appropriate management of cervical degenerative disc disease, ultimately contributing to improved patient care and a better understanding of cervical spine degeneration.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Peng B, DePalma MJ. Cervical disc degeneration and neck pain. J Pain Res. 2018 Nov 14;11:2853-2857. doi: 10.2147/JPR.S180018. PMID: 30532580; PMCID: PMC6241687.
2. Lucka E, Wareńczak-Pawlicka A, Lucki M, Lisiński P. The impact of increased computer screen time during the COVID-19 pandemic on the occurrence of upper part of musculoskeletal diseases among health personnel. Sci Rep. 2024 Aug 31;14(1):20257. doi: 10.1038/s41598-024-70942-1. PMID: 39217191; PMCID: PMC11366007.
3. Skrzypiec DM, Pollintine P, Przybyla A, Dolan P, Adams MA. The internal mechanical properties of cervical intervertebral discs as revealed by stress profilometry. Eur Spine J. 2007 Oct;16(10):1701-9. doi: 10.1007/s00586-007-0458-z. Epub 2007 Aug 2. PMID: 17671801; PMCID: PMC2078298.
4. Scarcia L, Pileggi M, Camilli A, Romi A, Bartolo A, Giubbolini F, Valente I, Garignano G, D'Argento F, Pedicelli A, Alexandre AM. Degenerative Disc Disease of the Spine: From Anatomy to Pathophysiology and Radiological Appearance, with Morphological and Functional Considerations. J Pers Med. 2022 Nov 1;12(11):1810. doi: 10.3390/jpm12111810. PMID: 36579533; PMCID: PMC9698646.
5. Winegar BA, Kay MD, Taljanovic M. Magnetic resonance imaging of the spine. Pol J Radiol. 2020 Sep 25;85:e550-e574. doi: 10.5114/pjr.2020.99887. PMID: 33101557; PMCID: PMC7571515.
6. Guvercin AR, Arslan E, Hacifazlioglu C, Kanat A, Arslan EA, Yazar U. Age- and gender-related radiological changes of the cervical spine: A study with largest magnetic resonance imaging database of 5672 consecutive patients. J Craniovertebr Junction Spine. 2023 Jan - Mar;14(1):84-92. doi: 10.4103/jcvjs.jcvjs_9_23. Epub 2023 Mar 13. PMID: 37213574; PMCID: PMC10198207.
7. Di Muzio B, Adel K, Pfirrmann grading system (spine). Reference article, Radiopaedia.org
8. Suzuki A, Daubs MD, Hayashi T, Ruangchainikom M, Xiong C, Phan K, Scott TP, Wang JC. Patterns of Cervical Disc Degeneration: Analysis of Magnetic Resonance Imaging of Over 1000 Symptomatic Subjects. Global Spine J. 2018 May;8(3):254-259. doi: 10.1177/2192568217719436. Epub 2017 Aug 17. PMID: 29796373; PMCID: PMC5958484.

9. Matsumoto M, Fujimura Y, Suzuki N, Nishi Y, Nakamura M, Yabe Y, Shiga H. MRI of cervical intervertebral discs in asymptomatic subjects. J Bone Joint Surg Br. 1998 Jan;80(1):19-24. doi: 10.1302/0301-620x.80b1.7929. PMID: 9460946.
10. Wang XR, Kwok TCY, Griffith JF, Man Yu BW, Leung JCS, Wáng YXJ. Prevalence of cervical spine degenerative changes in elderly population and its weak association with aging, neck pain, and osteoporosis. Ann Transl Med. 2019 Sep;7(18):486. doi: 10.21037/atm.2019.07.80. PMID: 31700922; PMCID: PMC6803181.
11. Karki DB, Gurung G, Adhikary KP, Ghimire RK. Magnetic resonance imaging findings in degenerative disc disease of cervical spine in symptomatic patients. J Nepal Health Res Counc. 2015 Sep-Dec;13(31):196-200. PMID: 27005711.
12. Maurya RK, Ali S, Singh B, Pant MK, Kumar P, Mittal P, Bhatiya R. A Comparative study of degenerative changes in different segments of cervical intervertebral discs using 1.5 T Magnetic Resonance Imaging. NeuroQuantology.2022;20(22):1139–1146.doi: 10.48047/nq.2022.20.22.NQ10089.