



A Comparative study of degenerative changes in different segments of cervical intervertebral discs using 1.5 T Magnetic Resonance Imaging

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Abstract:

The cervical spine is the most mobile part of the vertebral column & Cervical spondylosis is one of the leading causes of chronic neck pain. This prospective observational study was done on 200 subjects of the age group 18-85 years & subjects were further sub-categorized into different age groups and gender. The most common degenerative changes were seen at C5-C6 (77%) followed by C6-C7 (63.5%) and C4-C5 (39.9%) vertebral levels. The severity of disc degeneration was graded according to the Pfirrmann classification system. Out of 200 subjects, 148 subjects had cervical degenerative disc disease in one or more disc levels. So a total of 1036 discs were assessed, out of which 304 discs showed degenerative changes. 36.8% of total degenerated discs showed grade 4 degeneration and 25.7% grade 3 degeneration. Out of 148 subjects in which disc degeneration was noticed, degenerative changes at solitary disc levels were seen in 29.7% (n=44) and at multiple levels in 70.3% (n=104). The lower Segment of the cervical spine is more prone to degenerative changes in the intervertebral disc. MRI is one of the best diagnostic tools to identify early degenerative changes in the cervical spine. The early diagnosis of cervical spondylosis and its complications like myelopathy would help reduce the burden of this incapacitating morbidity.

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INTRODUCTION

MRI is now emerging as the radiological imaging modality of choice to diagnose diseases of the vertebral column and intervertebral discs (IVD). MRI is highly sensitive to detect anatomical abnormalities in their early stage. Cervical spondylosis broadly describes cervical disc degeneration, which is age-related and chronic and also affects other parts of the cervical vertebra, like facet and other joints and associated soft tissues. The cervical spine is the most mobile part of the vertebral column with almost 600 movements per hour in an average adult person, thus it is highly susceptible to degenerative changes. Cervical spondylosis is one of the leading causes of chronic neck pain.[1]



Cervical spondylosis is associated with three clinical syndromes: Axial neck pain; cervical radiculopathy and cervical myelopathy. Chronic degenerative changes in the cervical disc result in increased mechanical stress on the cervical spine which causes osteophyte formation and secondary degeneration in surrounding structures like facet joints, ligamentum flavum & posterior longitudinal ligament. These degenerative changes along with the associated spinal nerve impingement cause all three clinical syndromes mentioned above.[2]

Many asymptomatic subjects also show evidence of cervical disc degeneration.[3] According to M. Matsumoto et al approximately 25% of adults below the age of 40, 50% of adults over the age of 40 and 85% of adults above the age of 60 show some level of degenerative changes in their intervertebral discs. M. Matsumoto et al also found that the Intervertebral disc between C5& C6 is the most common site for disc degeneration followed by C6-C7 And C4-C5. [4]

Materials and Methods

This prospective observational study was done on 200 subjects of the age group 18-85 years. MRI Data was collected from the Department of Radiology, Govt Doon Medical College & Hospital, Dehradun after obtaining the required consent from participating subjects. For this study subjects were categorized into symptomatic (n=170) and asymptomatic (n = 30) according to the complaints for which MRI was requested by the attending physician. Symptomatic subjects consisted of patients who had complaints of neck pain or radiculopathy or both. Asymptomatic Subjects consisted of patients who came for MRI of any other region and their cervical spine was examined with their consent. Subjects were further sub-categorized into different age groups and gender.

MRI examinations were performed with the help of MRI Machine - uMR580 Full Digital 1.5T MR (United Imaging Healthcare) using a neck spine array volume coil (Large size). Images were acquired in sagittal, coronal and axial planes in both T1 and T2 weighted Spin echo, the field of view 50 cm, slice thickness 1mm and no slice gap. No contrast enhancement was done during these MRI examinations. All MRI images were interpreted by senior consultant radiologists and the status of disc degeneration was noted at all cervical vertebral levels. Disc degeneration was graded according to the Pfirrmann classification system.[5] (Table 1)

Statistical analysis was performed using MS Excel 2021 and results were presented as appropriate tables and figures.

Stage of degeneration	Structure	Distinction of nucleus and annulus	Signal intensity	Height of IVD
Grade 1	Homogenous, bright white	Clear	Hyperintense, isointense to CSF	Normal
Grade 2	Inhomogenous with or without horizontal bands	Clear	Hyperintense, isointense to CSF	Normal



Stage of degeneration	Structure	Distinction of nucleus and annulus	Signal intensity	Height of IVD
Grade 3	Inhomogenous, gray	Unclear	Intermediate	Normal to slightly decreased
Grade 4	Inhomogenous, gray to black	Lost	Intermediate to hypointense	Normal to moderately decreased
Grade 5	Inhomogenous, black	Lost	Hypointense	Collapsed disc space
Table 1: The Pfirrmann classification system of disc degeneration (MRI based)				

Results

200 MRI examinations were performed during the period of study. Out of which 133 (66.5%) were males and 67 (33.5%) were females. The mean age of the total sample population was 51.2 ± 12.2 (range 18-85). The mean age of the male population in the sample was 49.8 ± 15.9 (range 18-85). The mean age of the female population in the sample was 55.4 ± 9.9 (range 29-74). Out of 200 subjects 170 were symptomatic (male= 113; female= 57) and 30 were asymptomatic (male = 20; female = 10).

26% of total subjects had no disc degeneration (n=52) - which constituted 22.6% (n=30) of all males and 32.8% (n=22) of all females. In symptomatic patients, no disc degeneration was seen in 15.3% (n=26) - which constituted 10.6% (n=12) of symptomatic males and 24.6% (n=14) of symptomatic females; in asymptomatic patients, no disc degeneration was seen in 86.7% (n=26)- which constituted 90% (n=18) of asymptomatic males and 80% (n=8) of asymptomatic females.

Degenerative changes in cervical disc were seen in 74% (n=148) of total subjects- which constituted 77.4% (n=103) of total males and 67.2% (n=45) of total females. In Symptomatic patients, disc degeneration was seen in 84.7% (n=144)- which constituted 89.4% (n=101) of symptomatic males and 75.4% (n=43) of symptomatic females. Among asymptomatic subjects, 13.3% (n=4) had disc degeneration - which comprised 10% (n=2) of asymptomatic males and 20% (n=2) of asymptomatic females. Age and gender distribution of cases of cervical disc degeneration are shown in table 2.

Out of 148 subjects in which disc degeneration was noticed, degenerative changes at solitary disc levels were seen in 29.7% (n=44) and at multiple levels in 70.3% (n=104). The most common degenerative changes were seen at C5-C6 (77%) followed by C6-C7 (63.5%) and C4-C5 (39.9%) vertebral levels. (Shown in Fig 1).

The severity of disc degeneration was graded according to the Pfirrmann classification system. Out of 200 subjects, 148 subjects had cervical degenerative disc disease in one or more disc levels. So a total of 1036 discs were assessed. Out of which 304 discs showed degenerative changes. 36.8% of total degenerated discs showed grade 4 degeneration and 25.7% grade 3 degeneration.



Age Group	Gender	Symptomatic		Asymptomatic	
		Count (n)	Percentage	Count (n)	Percentage
18- 30		08 (n=15)	53.33%	0 (n=5)	0%
	Male	6 (n=9)	66.6%	0 (n=5)	0%
	female	2 (n=6)	33.3%	0 (n=0)	0%
31-40		17 (n=22)	77.27%	0(n=5)	0%
	Male	12 (n=15)	80%	0 (n=2)	0%
	female	5 (n=7)	71.4 %	0 (n=3)	0%
41-50		26 (n=38)	68.42%	1 (n=5)	20%
	Male	17 (n=22)	77.3%	1 (n=3)	33.3%
	female	9 (n=16)	56.25%	0 (n=2)	0%
51-60		40 (n=42)	95.23%	0 (n=5)	0%
	Male	28 (n=30)	93.33%	0 (n=3)	0%
	female	12 (n=12)	100%	0 (n=2)	0%
61-70		28 (n=28)	100%	1 (n=5)	20%
	Male	15 (n=15)	100%	1 (n=4)	25%
	female	13 (n=13)	100%	0 (n=1)	0%
71-85		25 (n=25)	100%	2 (n=5)	40%
	Male	23 (n=23)	100%	1 (n=3)	33.3%
	female	2 (n=2)	100%	1 (n=2)	50%
Total		144 (n=170)	84.70%	4 (n=30)	13.33%
	Male	101 (113)	89.4%	2 (n=20)	10%
	female	43 (57)	75.4%	2 (n=10)	20%

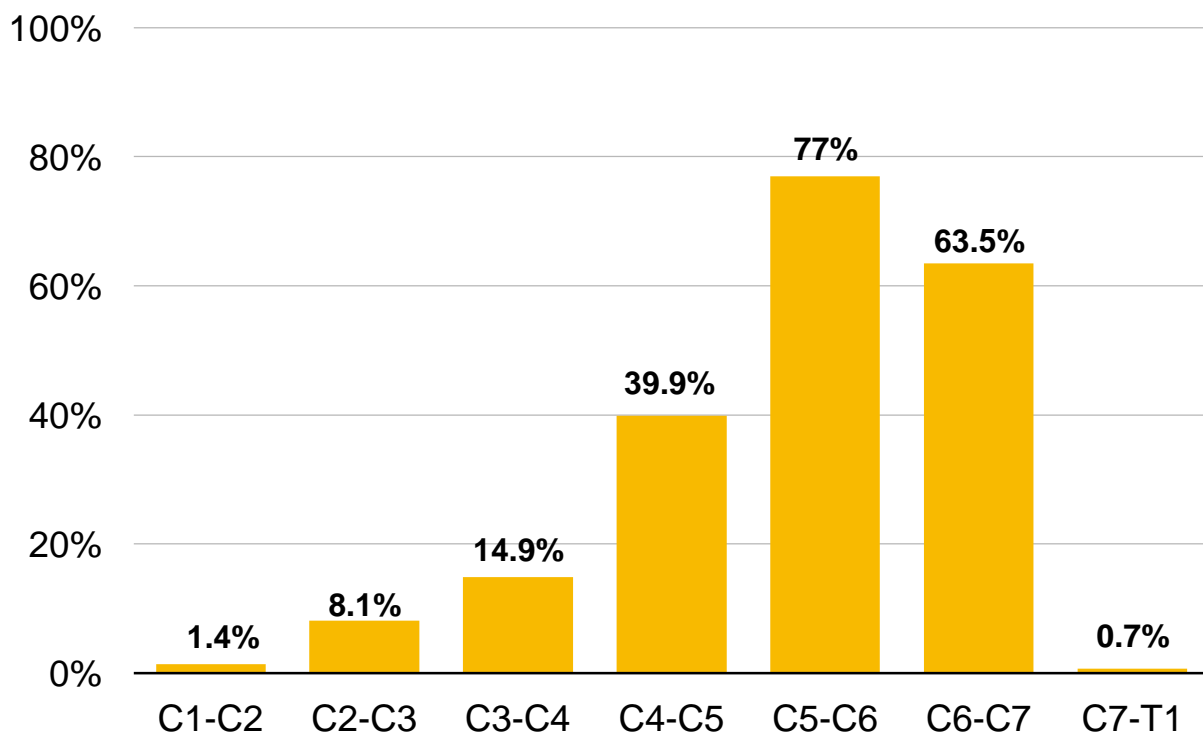
Table 2: Age and gender distribution of cervical disc degeneration patients. (Number in the parenthesis suggests the total number of subjects in that category.)



The Pfferrmann classification for degenerative disc disease						
Disc Level	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total (n=148)
C1-C2	1 (50%)	1 (50%)	-	-	-	2 (1.4%)
C2-C3	2 (16.6%)	4 (33.3%)	4 (33.3%)	2 (16.6%)	-	12 (8.1%)
C3-C4	9 (40.9%)	6 (27.3%)	3 (13.6%)	2 (9.1%)	2 (9.1%)	22 (14.9%)
C4-C5	4 (6.8%)	5 (8.5%)	18 (30.5%)	23 (39%)	9 (15.3%)	59 (39.9%)
C5-C6	10 (8.8%)	6 (5.3%)	22 (19.3%)	48 (42.1%)	28 (24.6%)	114 (77%)
C6-C7	2 (2.1%)	3 (3.2%)	31 (33%)	37 (39.4%)	21 (22.3%)	94 (63.5%)
C7-T1	-	1 (100%)	-	-	-	1 (0.7%)
Total	28 (9.2%)	26 (8.6%)	78 (25.7%)	112 (36.8%)	60 (19.7%)	304 (n=1036) (29.3%)

Table 3: Grading of degenerative disc disease in the study population.

■ Fig 1: % of discs showing degenerative changes at different cervical levels



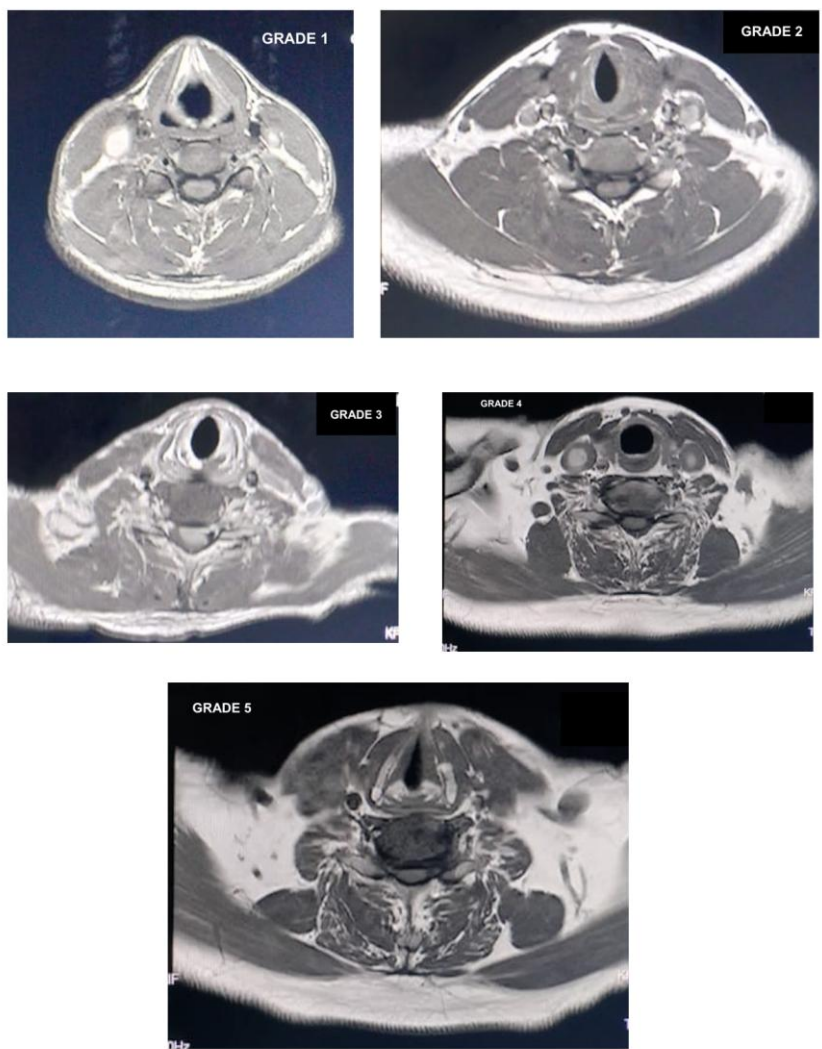
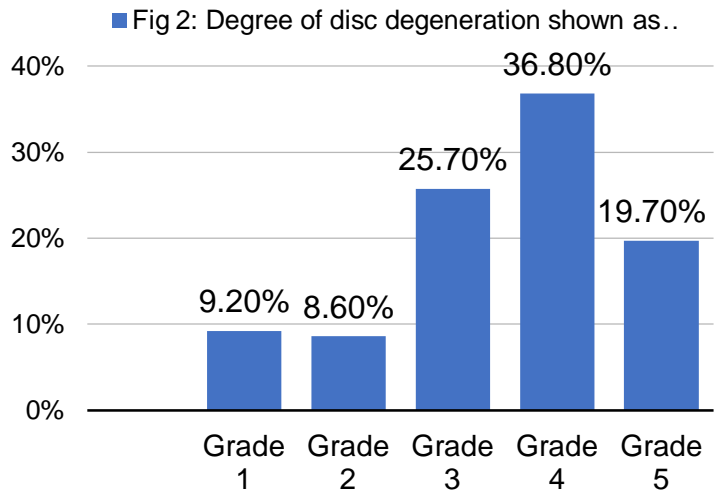


Fig 3: Different stages of disc degeneration (The Pfirrmann grades)



Discussion:

Cervical spondylosis is a general term used for the degenerative cascade that affects the complete cervical spine and may be seen radiographically in both symptomatic and asymptomatic individuals. Cervical spondylosis is a common disease of middle age men and generally presents in the age group of 40-60. with a male to female ratio of 3:2. [2] our study also confirms this observation. Degeneration of annulus fibrosus and dehydration of inner nucleus pulposus causes disc height reduction and disc prolapse. [6]

Cervical spine 3 -7 are considered to be the motion segment of cervical spine with mobility being maximum at C5- C6 level and most frequently affected by degenerative disc changes. In our study the most common degenerative changes were seen at C5-C6 followed by C6-C7 and C4-C5 vertebral levels and same has been documented other studies [4,6,7] In present study 15.3% of symptomatic subjects had no disc degeneration. A similar study carried out on 342 symptomatic patients in Iran showed 21.3 % subjects to have normal results.[1]

Some of the studies we reviewed did not take into account the gender variation among patients of cervical disc degeneration. [8,9,10]

Quantitative MRI in studies can detect changes in disc hydration or composition non-invasively with desired accuracy. [11] Recent studies have used MRI to assess disc degeneration *in vivo* with regard to potential risk factors.

Early signs of disc degeneration can also be seen in an asymptomatic individual. [12,13] This finding is also seen in our study. Islam et al found the prevalence of disc degeneration to be 3% in the 15-year-old population and 100% in 65 yr old population. Our study also found degenerative disc disease in 100% population above the age of 60 years. Mann et al support the hypothesis that some structural changes in the spine are not detected by MRI due to technical shortcomings. [14]

In the present study, we have used the Pfirrmann classification system for grading disc degenerative changes. Although this classification system was designed originally for lumbar disc degeneration, but it is extensively established for use in cervical disc degeneration as well. this classification system was modified a little by Griffith et al for better differentiation classification in the older population. [5,15]

Conclusion:

The lower Segment of the cervical spine is more prone to degenerative changes in the intervertebral disc. In our study C5-C6 is the most common segment followed by C6-C7 & C4-C5 with respect to degenerative changes in the cervical spine. MRI is one of the best diagnostic tools to identify early degenerative changes in the cervical spine. The early diagnosis of cervical spondylosis and its complications like myelopathy would help reduce the burden of this incapacitating morbidity.

Conflict of interest: None

Acknowledgment

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