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Evaluation and Grading of Degenerative Changes of Cervical Spine Using Magnetic Resonance Imaging

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Abstract: *The Degenerative Disc Disease (DDD) is considered to be major cause of pain and disability in the adult working population. It is an age associated condition that is caused due to the degeneration of intervertebral discs and narrowing of intervertebral disc spaces. To evaluate DDD different imaging modalities are used, but MRI is the preferred examination since it provides excellent soft tissue contrast, it does not involve ionizing radiation and it is not invasive.*

Key words: *Degenerative disc disease, foraminal stenosis, disc protrusion, narrowing of the disc ..*

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I. Introduction

• The Degenerative Disc Disease (DDD) is considered to be major cause of pain and disability in the adult working population.

• It is an age associated condition that is caused due to the degeneration of intervertebral discs and narrowing of intervertebral disc spaces. In the case of cervical DDD the symptoms are mainly neck pain and stiffness. There is significant rise in this condition among the Indian population due to the change in life style and poor ergonomics in the work places. If the degeneration is severe then back pain and muscle weakness occur as well and cervical spine surgery is considered.

• To evaluate DDD different imaging modalities are used, but MRI is the preferred examination since it provides excellent soft tissue contrast, it does not involve ionizing radiation and it is not invasive. Using sagittal images of the cervical spine intervertebral disc spaces are measured and detects the degenerated discs.

• Computerized approaches for the detection of degenerated discs based on disc morphology have been proposed in the past. In this study a different approach which exploits the differentiation of the disc texture is used for classification purposes. When a disc is degenerated alterations on its biochemical composition occur. These alterations affect the texture of MR images. More specifically the loss of hydration results in speckled or darker appearance of the disc in T2-weigted images. The proposed image analysis system uses textural features calculated from the intervertebral discs, which comprise the regions of interest, in order to classify them as normal or degenerated (narrowed).

• A complete physical examination of the neck, arms, lower extremities and frequency of symptoms of pain, numbness, tingling and weakness were clinically evaluated.

• X-rays will often show a narrowing of the spaces between the vertebral bodies, which indicates that the disc has become very thin or has collapsed. Bone spurs begin to form around the edges of the vertebral bodies and the edges of the facet joints in the spine. These bone spurs can be seen on an x-ray and they are called osteophytes. As the discs collapse and bone spurs form, the space available for the nerve roots and the spinal cord starts to shrink. The nerve roots are especially vulnerable to compression at the exit of the spinal canal, the neuroforamen.

• CT scan can be used in order to evaluate the bony anatomy in the cervical spine. The method is non-invasive, it is quick, it provides excellent visualization of bone in the axial projection and shows the root-canals and

paraspinal area. It assists to detect bony elements narrowing the spinal canal, and thus it can show how much space is available for the nerve roots and spinal cord within the spinal canal. The main drawbacks are that it cannot image soft tissues (discs and nerves), and if a large area is imaged, there will be significant irradiation of the patient.

• Magnetic resonance imaging (MRI) is a useful tool in the diagnosis of DDD. It is able to image through multiple sections of the spine and show any abnormality of soft tissues, nerves and ligaments. The test also can be used to verify: loss of water in a disc, facet joint hypertrophy (enlargement), stenosis (narrowing of spinal canal), or a herniated disc (protrusion or rupture of the intervertebral disc). It helps determining where the nerve roots or spinal cord are being compressed. Thus MRI has become the most common test, to evaluate the cervical spine.

II. Aims & Objectives:

• The objective of this study is

• To evaluate, characterize and grade the degenerative changes of cervical spine using MRI.

• To analyze the distribution pattern of different grades of cervical degenerative changes in a group of patients from the Indian subcontinent.

III. Materials & Methods:

- Study design: Descriptive study
- Study sample:75patients(June 2021 to May 2022)

Inclusion Criteria:

All patients who are detected to have any of the following degenerative changes of the cervical spine Disc degeneration,

1. Posterior disc protrusion,
2. Anterior disc protrusion,
3. Narrowing of the disc space,
4. Foraminal stenosis.

Exclusion criteria:

1. Patients who are detected to have cervical spine fracture.
2. Patients with spinal cord lesions like intramedullary tumours, demyelination etc.
3. Post operative patients.
4. Patients who are diagnosed with spondylolisthesis.

Equipment: All the MR scans in this study were performed using a 1.5 T MRI scanner (GE Medical systems).

IV. Discussion

• The introduction of new techniques to the magnetic resonance imaging (MRI) armamentarium provides an MRI examination that overcomes many of the disadvantages noted in earlier reports.

• An analysis of the various advantages and disadvantages of MRI, plain film myelography, and computed tomographic myelography pointed to a potential revision of the sequence of diagnostic studies and the workup of cervical degenerative disease.

• MRI may now be the appropriate first test for the evaluation of the cervical spine in a patient with symptoms referable to degenerative disease when therapeutic intervention is considered.

• Modic et al. suggested that an initial T1-weighted sagittal image with a 3-mm slice thickness will provide excellent contrast evaluation of the vertebral body marrow, disc space height, neural canal, and spinal cord. Disc herniation, canal stenosis, subluxation, and malalignment can be appreciated.

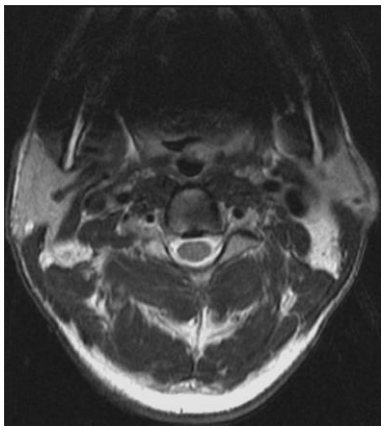
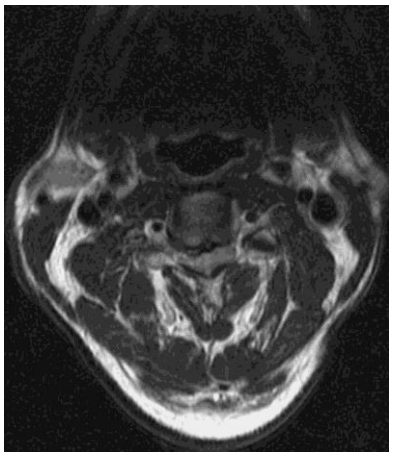
• If necessary, additional oblique views through the neural foramen can be obtained. Axial gradient-echo fast sequences, with low flip angles, will provide a second orthogonal plane with increased conspicuousness of extradural changes relative to the neural foramen and thecal sac.

• Factors Influencing Degenerative Changes of the Spine In our study the disc degeneration is seen to follow a linear association with age. We found that disc degeneration is least in less than 30 years age group with 152 (86.9%) normal discs and 23 (13.1%) discs with grade 1 changes, while none of the discs showed grade 2 degeneration. Maximum amount of disc degeneration is noted in the age group of greater than 60 years. Here, only 55 discs (43.7%) were normal. 42 (33.3%) discs were grade 1 and 29 (23.0%) discs were grade 2.

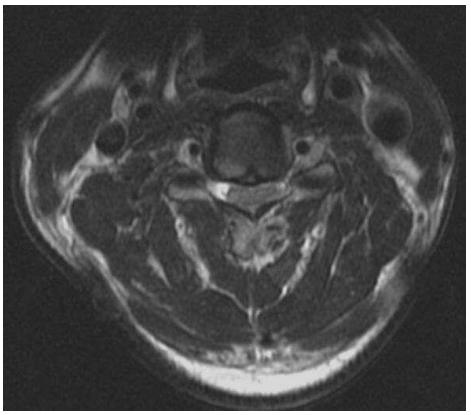
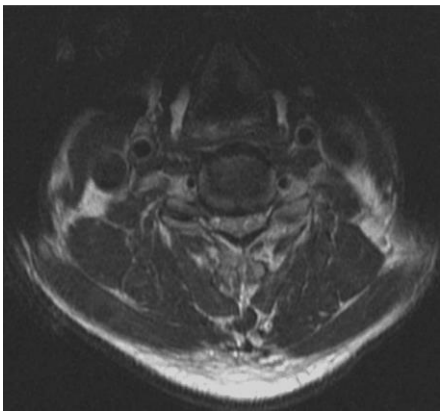
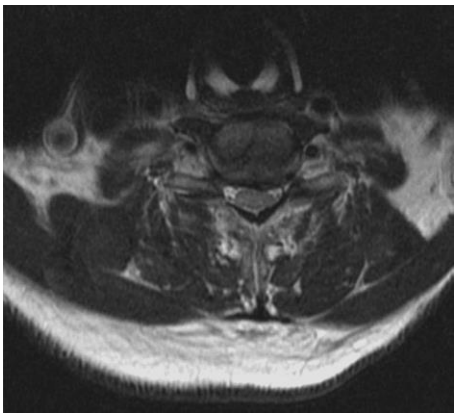
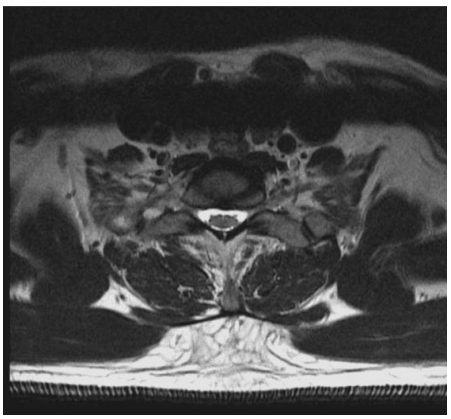
• There is a linear association noted between each degenerative change viz. disc degeneration, posterior disc protrusion, anterior disc protrusion, narrowing of disc space and forminal stenosis with age. As age progresses, the frequency of a particular degenerative change is also seen increasing.

MRI based Grading system for cervical degenerative disc disease

Parameter	Grade	Description
Disc degeneration	0	Bright as or slightly less bright than CSF.
	1	Dark and/or speckled.
	2	Almost black.
Posterior disc protrusion	0	Disc material confined within the posterior margin of the vertebral body.
	1	Disc material protruding beyond the posterior margin of the vertebral body without cord compression.
	2	Beyond vertebral body with cord compression.
Anterior disc protrusion	0	Disc material confined within the anterior margin of the vertebral body.
	1	Disc material protruding beyond the anterior margin of the vertebral body.
Narrowing of the disc space	0	No narrowing or less than 25% loss in height compared with the most adjacent normal disc space.
	1	25% to 50% loss of height.
	2	More than 50% loss of height.
Foraminal stenosis	0	No obliteration of intraforaminal fat.
	1	Disc material or bony spurs obliterating intraforaminal fat unilaterally or bilaterally.

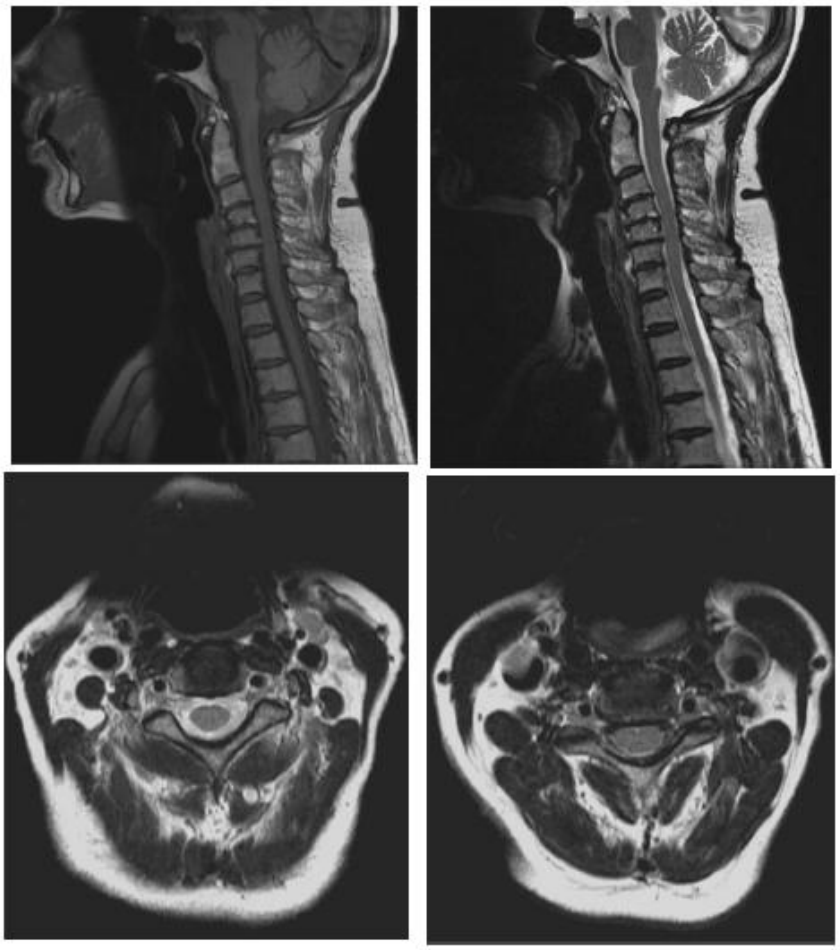



Age: 63 years Male
Clinical details: Neck stiffness and right upper limb numbness.

Grading of degenerative changes:

	Disc Degeneration	Posterior Disc Protrusion	Anterior Disc Protrusion	Narrowing of Disc Space	Foraminal Stenosis
C2-3	0	0	0	0	0
C3-4	1	2	1	1	1
C4-5	1	1	1	0	1
C5-6	1	2	1	1	1
C6-7	1	1	1	1	1
C7-D1	0	0	0	0	0

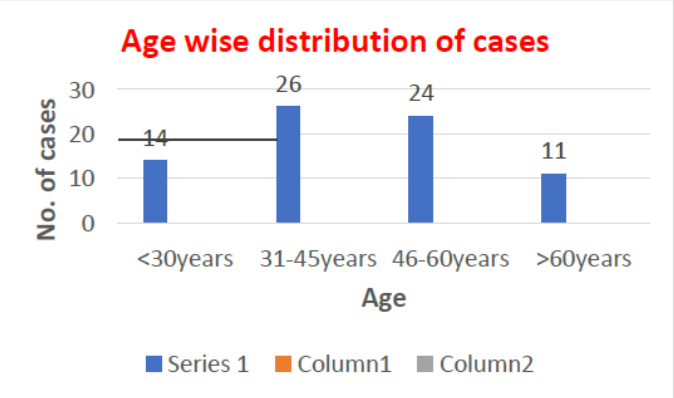


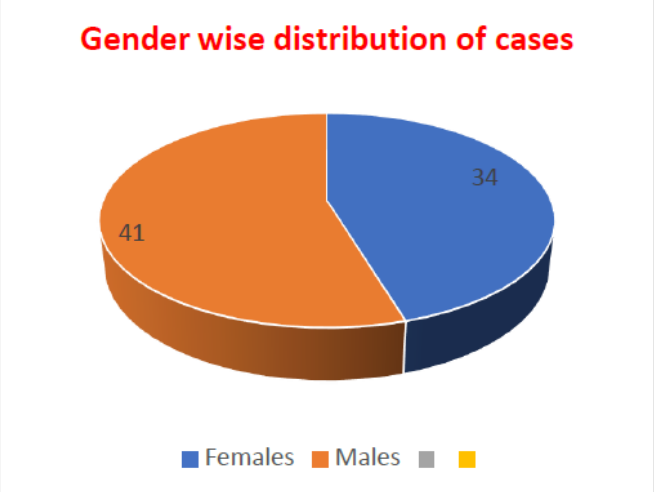
Age: 67 years Female
Clinical details: Neck stiffness and burning pain.

V. Results

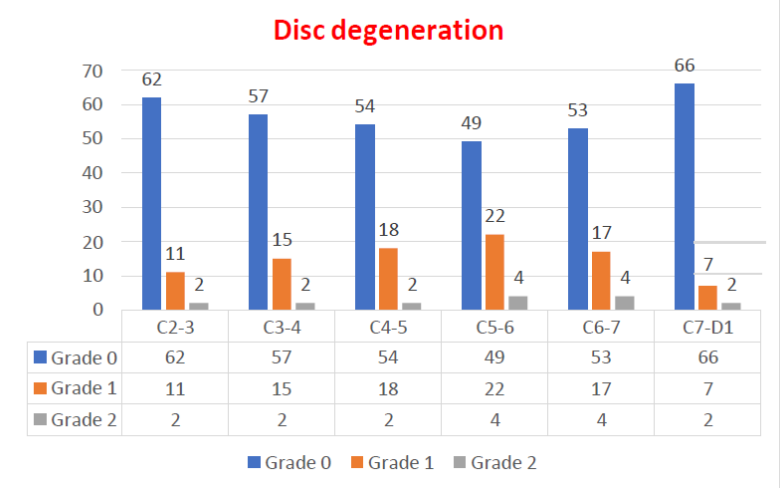
• The present study was carried out to analyze the degenerative changes using MR evaluation of cervical spine. Findings in the patients studied were graded in each cervical disc level from C1-2 to C7-D1 level (total 6 disc levels)

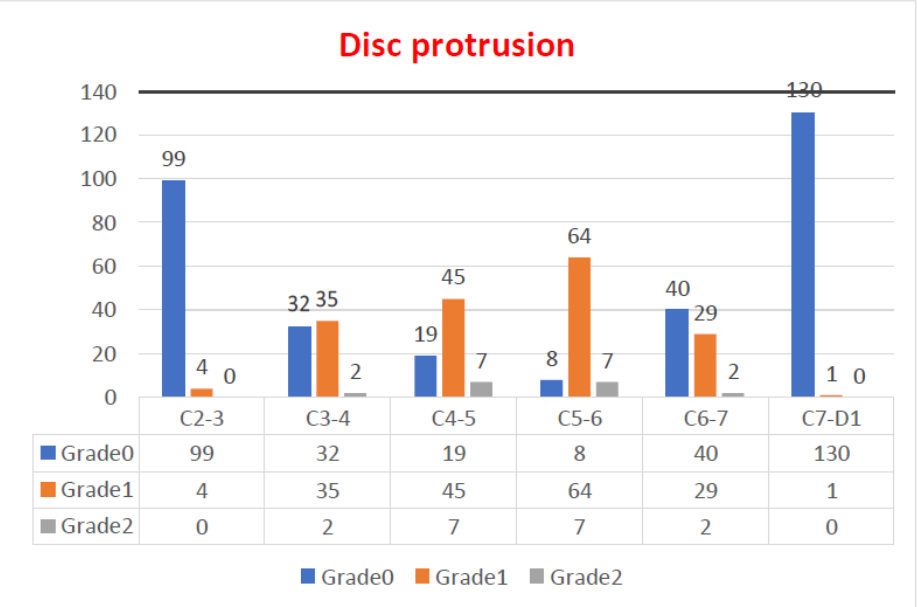
• Data analysis 75 patients who were referred for complete cervical spine MRI were included in the study. The observations of these 75 cases were compiled and analyzed.





Distribution of degenerative changes at each disc level





VI. Conclusion:

Magnetic Resonance Imaging, with its excellent soft tissue contrast and the multiplanar imaging capability is a versatile imaging modality for diagnosing andgrading degenerative disc disease of the cervical spine. MRI based grading of degenerative disc disease of cervical spineis considered as a widely accepted and easy-to-reproduce grading system whichalso helps in assessing the severity and follow up of this disease condition moreprecisely.

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