“ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS”

BY

Dr. T. NISHANTH VARMA

DISSERTATION SUBMITTED TO
SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH , TAMAKA, KOLAR, KARNATAKA

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF MEDICINE

IN

RADIODIAGNOSIS

UNDER THE GUIDANCE OF

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"ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS"

ABSTRACT

Introduction

Aims & Objectives

Methods

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"ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS" ABSTRACT Introduction Cervical spinal canal stenosis (SCS) and neural foraminal stenosis (NFS) are common degenerative disorders causing significant morbidity due to compression of spinal cord and exiting nerve roots. Degenerative changes such as facet osteophytes, disc herniation and ligament ossifications progressively narrow the canal and foramina, leading to radiculopathy and myelopathy. MRI is now the gold standard for cervical spine evaluation, offering high resolution, multiplanar images with excellent soft tissue contrast and no ionising. To objectively quantify stenosis severity on MRI, standardized grading scales have been introduced. For example, "Kang et al. (2010) developed a reliable MRI-based system for cervical NFS oblique sagittal imaging, and Park et al. (2013) proposed a sagittal MRI classification for spinal canal compromise". These systems have demonstrated high inter- observer agreement and correlate with clinical symptoms, suggesting clinical relevance in guiding patient management. Aims & Objectives To evaluate MRI based Kang grading system for cervical SCS and correlate with JOA score. To evaluate MRI based Park grading system for cervical NFS and correlate with NDI. Methods In a single-center observational study (Jan–Dec 2024), 40 adult patients with symptomatic cervical spine complaints underwent MRI (1.5 T Siemens Magnetom Avanto). Standard imaging included T1- and T2-weighted sagittal sequences and oblique sagittal T2-weighted views to optimally visualize the neural foramina. Cervical canal stenosis was graded per Kang et al.'s criteria, and foraminal stenosis per Park et al.'s criteria. Neurological status was quantified using the JOA score for myelopathy and NDI for radiculopathy. Pearson correlation analysis was performed to assess relationships between MRI grades and clinical scores (significance threshold $p \le 0.05$). Results The cohort (n=40) had a mean age of 50.2±12.96 years and was 52.5% female. MRI grading showed that upper cervical levels were mostly normal, whereas lower levels exhibited more stenosis. For foraminal stenosis, 95% of patients had no stenosis (Grade 0) at C2–C3, whereas at C6–C7 only 40% were Grade 0 and 30% had severe (Grade III) narrowing. Similarly, for canal stenosis, 87.5% had no stenosis at C2–C3, while at C5–C6 and C6–C7 the majority (82.5% and 75%, respectively) had some stenosis (with large subsets in Grades II–III). Importantly, higher MRI grades corresponded to worse clinical scores. Pearson analysis revealed a strong negative correlation between Kang grades (canal stenosis) and JOA score ($r=-0.949$, $p<0.001$), and a strong +ve corelation between Park grades (foraminal stenosis) and NDI ($r=0.879$, $p<0.001$). In other words, patients with more severe MRI stenosis consistently had greater neurological impairment (lower JOA and higher NDI). Conclusion Standardized MRI grading using Kang's and Park's systems proved to be reliable indicators of cervical stenosis severity and were highly predictive of clinical status. The observed strong correlations between MRI grades and disability scores reinforce MRI's diagnostic and prognostic value in cervical stenosis. In practice, applying these grading scales can improve the objectivity of imaging reports and help clinicians identify patients at risk for neurological deficits. Overall, the study supports the clinical utility of Kang and Park MRI grading in guiding the evaluation and management of cervical SCS and NFS. Keywords SCS; NFS; MRI grading system; Kang classification; Park classification; Clinical correlation; JOA score; NDI. INTRODUCTION Spinal stenosis denotes the narrowing of nerve pathways due to multiple pathological reasons, leading symptoms like numbness, pain, and wekness. The disease can impact three separate anatomical areas within the spinal canal. The central canal, containing the SC, may experience narrowing in the AP dimension. This constriction can impinge upon neural tissues and impede blood circulation to the SC in the cervical region or the cauda equina in the lumbar region. Secondly, the NF—openings through which nerve roots escape the spinal cord—may become occluded due to intervertebral disc herniation, facet joint athrosis and ligamentam flavum hypertrophy, or instability resulting from vertebral slippage. Finally, in the lumbar spine, the lateral recess—situated along the pedikle where the nerve root traverses before to exiting through the NF —may experience compression.1–3 CSCS and CFS are prevalent spinal illnesses in symptomatic patients, frequently leading to significant morbidity and diminished quality of life. 4,5 These disorders primarily arise from a constriction of the Cervical SC or NF, resulting in compression of spinal cord and nerve roots5,6 The C-spine, given its anatomical and biomechanical complexity, is particularly prone to degenerative and structural changes that can lead to stenosis7 "Narrowing of the cervical SC can be caused due to several conditions like degenerative changes, tumors, infections, trauma"4 Cervical NFS can be caused by degenrative osteophyts, facet hyprtrophy, or laterally herniated disks. The progressive constriction of the NF by this anatomical changes may result in nerve root impingment, inflamation, or both, which could cause cervical radiculopaty.8 The growing prevalence of these conditions, particularly in the aging population, underscores the need for accurate and early diagnostic modalities to guide effective clinical management.7,8 MRI has revolutionized field of spinal imaging and is now regarded as the gold standard for evaluating cervical spine pathologies. Its unique ability to provide high-rezolution images with excellent soft-tissue contrast enables detailed visualization of spinal cord, nerve roots, intervertebral discs, and adjacent structures. Unlike other imaging techniques, such as CT or radiography, MRI is non-invasive and does not expose patients to ionizing radiation, making it ideal for repeated imaging, particularly in patients requiring long-term follow-up. Furthermore, MRI's advanced capabilities, such as sagittal and axial views, allow for precise measurement of the SCD, degree of foraminal narrowing, and evaluation of associated soft- tissue abnormalities. The clinical significance of MRI extends beyond diagnosis, as it plays a critical role in determining the prognosis and guiding treatment strategies.5 The increasing reliance on MRI in clinical practice reflects its unparalleled value in understanding the anatomical and pathological aspects of cervical stenosis. However, the true potential of MRI lies in its ability to bridge the gap between clinical symptoms and imaging findings. By correlating MRI features with the severity of symptoms and functional outcomes, clinicians can adopt a more personalized approach to patient care, optimizing therapeutic decisions and improving overall outcomes. This study aims to comprehensively evaluate the role of MRI in assessing cervical SCS & cervical NFS among symptomatic patients. This study seeks to establish MRI as a reliable diagnostic and prognostic tool by analyzing the correlation between imaging findings and clinical presentations. In doing so, the study aspires to contribute to growing body of evidence supporting the integration of MRI into routine clinical workflows for cervical spine pathologies. REVIEW OF LITERATURE Gross Anatomy of the Spinal Cord The spinal cord lies within the SC but do not span the full length of the vertebral column. It averages about 45 cm in adult males and roughly 43 cm in adult females. Its diameter varies along its course, being about 1.27 cm across in the cervical and lumbar regions and narrowing to roughly 6.4 mm in the thoracic region. At its lower end the cord is anchored by the filum terminale, a fibrous (non-neural) extension of the pia mater that originates at the conus medullaris and attaches to the coccyx. In addition, roughly 20 to 21 pairs of denticulate ligaments, which are serrated lateral extensions of the pia mater, anchor the cord and serve as surgical landmarks along its anterolateral surface9 Except for the 1st cervical segment, each segment gives rise to paired dorsal (posterior) and ventral (anterior) nerve roots that merge to form the spinal nerves. The dorsal root of each nerve has an oval enlargement called the dorsal root ganglia, which contains the cell body of sensory neurons. These sensory neurons

LIST OF ABBREVIATIONS

MRI	**Magnetic Resonance Imaging**
CT	**Computed Tomography**
C-SPINE	**Cervical spine**
SCS	**Spinal Canal Stenosis**
NFS	**Neural Foraminal Stenosis**
NDI	**Neck Disability Index**
JOA	**Japanese Orthopedic Association**
PPV	**Positive Predictive Value**
NPV	**Negative Predictive Value**
IVD	**Intervertebral Disc**
CCD	**Cervical Canal Diameter**
SAC	**Space available for cord**
CSCI	**Cervical Spinal Cord Injury**
ACDF	**Anterior Cervical Discectomy and Fusion**
VAS	**Visual Analog Scale**

ABSTRACT

Introduction

Cervical spinal canal stenosis (SCS) and neural foraminal stenosis (NFS) are common disorders causing significant morbidity due to compression of spinal cord and exiting nerve roots. Degenerative changes such as facet osteophytes, disc herniation and ligament ossifications progressively narrow the canal and foramina, leading to radiculopathy and myelopathy.

MRI is now the gold standard for cervical spine evaluation, offering high resolution, multiplanar images with excellent soft tissue contrast and no ionization. To objectively quantify stenosis severity on MRI, standardized grading scales have been introduced. For example, Kang et al. (2010) developed a reliable MRI-based system for cervical Neural Foramen Stenosis (NFS), and Park et al. (2013) developed a MRI classification system for cervical Spinal Canal Stenosis (SCS). These systems have demonstrated high inter-observer agreement and correlate with clinical symptoms, suggesting clinical relevance in guiding patient management.

Aims & Objectives

- To evaluate the MRI based Kang grading system for cervical Spinal Canal Stenosis (SCS) and correlate with Japanese Orthopaedic Association (JOA) score.
- To evaluate the MRI based Park grading system for cervical Neural Foraminal Stenosis and correlate with Neck Disability Index (NDI).

Methods

In an analytical observational study, 40 adult patients with symptomatic cervical spine complaints underwent MRI C-spine. Standard imaging included T2-weighted sagittal sequences and oblique sagittal T2-weighted sequences to optimally visualize the neural foramina. Cervical canal stenosis was graded per Kang et al.'s criteria, and foraminal stenosis per Park et al.'s criteria. Neurological status was quantified clinically using the JOA score for cervical myelopathy and NDI for cervical radiculopathy. Pearson correlation analysis was performed to assess relationships between MRI grades and clinical scores (significance threshold $p \leq 0.05$).

Results

The cohort (n=40) had a mean age of 50.2±12.96 years and was 52.5% female. MRI grading showed that upper cervical levels were mostly normal, whereas lower levels exhibited more stenosis. For foraminal stenosis, 95% of patients had no stenosis (Grade 0) at C2–C3, whereas at C6–C7 only 40% were Grade 0 and 30% had severe (Grade III) narrowing. Similarly, for canal stenosis, 87.5% had no stenosis at C2–C3, while at C5–C6 and C6–C7 the majority (82.5% and 75%, respectively) had some stenosis (with large subsets in Grades II–III).

Importantly, higher MRI grades corresponded to worse clinical scores. Pearson analysis revealed a strong negative correlation between Kang grades (spinal canal stenosis) and JOA score ($r=-0.949$, $p<0.001$), and a strong positive corelation between Park grades (foraminal stenosis) and NDI ($r=0.879$, $p<0.001$). In other words, patients with more severe MRI stenosis consistently had greater neurological impairment (lower JOA and higher NDI).

Conclusion

Standardized MRI grading using Kang's and Park's systems proved to be reliable indicators of cervical stenosis severity and were highly predictive of clinical status. The observed strong correlations between MRI grades and disability scores reinforce MRI's diagnostic and prognostic value in cervical stenosis.

In practice, applying these grading scales can improve the objectivity of imaging reports and help clinicians identify patients at risk for neurological deficits. Overall, the study supports the clinical utility of Kang and Park MRI grading in guiding the evaluation and management of cervical SCS and NFS.

Keywords

Cervical Spinal Canal Stenosis (SCS); Cervical Neural foraminal Stenosis (NFS); MRI grading system; Kang classification; Park classification; Clinical correlation; Japanese Orthopaedic Association (JOA) score; Neck Disability Index (NDI).

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INTRODUCTION

Spinal stenosis refers to constriction of nerve pathways caused by various pathological factors, resulting in symptoms such as pain, numbness, and weakness. The condition can affect three distinct anatomical regions within the vertebral canal. First, the central canal, which houses the spinal cord, may become narrowed in the anterior-posterior dimension. This narrowing can compress neural structures and disrupt blood flow to the spinal cord in the cervical region or the cauda equina in the lumbar region. Second, the neural foraminal passages through which nerve roots exit the spinal cord can be compressed due to factors such as intervertebral disc herniation, hypertrophy of the facet joints and ligaments, or instability caused by vertebral slippage (spondylolisthesis). Lastly, in the lumbar spine, specifically the lateral recess—located along the pedicle where the nerve roots traverse before exiting through the neural foramina may become compressed.[1-3]

Cervical Spinal Canal Stenosis (SCS) and Neural Foraminal Stenosis (NFS) are among the most common spinal disorders seen in symptomatic individuals, often resulting in considerable morbidity and reduced quality of life.[4,5] These conditions primarily occur due to narrowing of the cervical spinal canal or neural foramina, leading to compression of the spinal cord and nerve roots.[5,6]

The cervical spine, given its anatomical and biomechanical complexity, is particularly prone to degenerative and structural changes that can lead to stenosis[7]. Narrowing of the cervical canal can be caused by several conditions including tumours, infections, trauma, degenerative changes like intervertebral disc herniation, osteophytes, and ossification of posterior longitudinal ligaments, which could cause cervical myelopathy[.4].

Cervical neural foraminal stenosis (NFS) or neural foraminal narrowing can be caused by degenerative osteophytes, facet hypertrophy, or laterally herniated discs. The progressive narrowing of the intervertebral foramina by these anatomical changes may result in nerve root impingement, inflammation, or both, which could cause cervical radiculopathy.[8] The growing prevalence of these conditions, particularly in the aging population, underscores the need for accurate and early diagnostic modalities to guide effective clinical management.[7,8]

Magnetic Resonance Imaging (MRI) has revolutionized the field of spinal imaging and is now regarded as the gold standard for evaluating cervical spine pathologies. Its unique ability to provide high-resolution images with excellent soft-tissue contrast enables detailed visualization of spinal cord, nerve roots, intervertebral discs, and adjacent structures.

Unlike other imaging techniques, such as Computed Tomography (CT) or Radiography, MRI is non-invasive and does not expose patients to ionizing radiation, making it ideal for repeated imaging, particularly in patients requiring long-term follow-up. Furthermore, MRI's advanced capabilities, such as sagittal and axial views, allow for precise measurement of the spinal canal diameter, degree of foraminal narrowing, and evaluation of associated soft-tissue abnormalities.

The clinical significance of MRI extends beyond diagnosis, as it plays a critical role in determining the prognosis and guiding treatment strategies.[5] The increasing reliance on MRI in clinical practice reflects its unparalleled value in understanding the anatomical and pathological aspects of cervical stenosis. However, the true potential of MRI lies in its ability to bridge the gap between clinical symptoms and imaging findings. By correlating MRI features with the severity of symptoms and functional outcomes, clinicians can adopt a more personalized approach to patient care, optimizing therapeutic decisions and improving overall outcomes.

This study aims to comprehensively evaluate the role of MRI in assessing cervical spinal canal stenosis and cervical foraminal stenosis among symptomatic patients. This study seeks to establish MRI as a reliable diagnostic and prognostic tool by analysing the correlation between imaging findings and clinical presentations. In doing so, the study aspires to contribute to the growing body of evidence supporting the integration of MRI into routine clinical workflows for cervical spine pathologies.

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AIMS & OBJECTIVES

AIMS & OBJECTIVES OF THE STUDY

- To evaluate the MRI based Kang grading system for cervical Spinal Canal Stenosis (SCS) and correlate with Japanese Orthopaedic Association (JOA) score.
- To evaluate the MRI based Park grading system for cervical Neural Foraminal Stenosis and correlate with Neck Disability Index (NDI).

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Gross Anatomy of the Spinal Cord

The spinal cord resides within the spinal canal but does not extend along the entire length of the vertebral column. In men, the spinal cord measures approximately 45 cm in length, whereas in women, it is about 43 cm long.[9] Its width varies, being around 1.27 cm in the cervical and lumbar regions and narrowing to 6.4 mm in the thoracic region. The spinal cord is anchored caudally by the filum terminale, a non-neural membrane originating from the conus medullaris that attaches to the coccyx. Additionally, 20 or 21 pairs of denticulate ligaments serve as surgical landmarks for the anterolateral segment of the spinal cord.[9]

The spinal cord is divided into 31 segments: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.[10] Each segment, except the first cervical, has paired dorsal and ventral roots that join to form spinal nerves. The dorsal roots feature an oval enlargement known as the dorsal root ganglion, which houses sensory neurons. These neurons are pseudounipolar, with a single nerve process dividing into a long peripheral receptor process and a shorter central process entering the spinal cord. Importantly, no synapses are present in the dorsal root ganglia. Spinal nerves exit the vertebral canal through intervertebral foramina, with the first cervical nerve emerging between the occipital bone and the atlas and the eighth cervical nerve exiting between the seventh cervical and first thoracic vertebrae. Below this level, all spinal nerves exit beneath their corresponding vertebrae.[9]

Spinal cord and vertebral column levels do not align due to differing growth rates during embryonic development. In the upper cervical region, the spinal cord segment corresponds to the vertebra with the same number. However, between C5 and C8, the spinal cord segment is one level higher than the corresponding vertebral body. In the thoracic region, the vertebral spinal process may be two levels above the cord segment, and in the lower thoracic and upper lumbar regions, the discrepancy increases to two or three levels.[9]

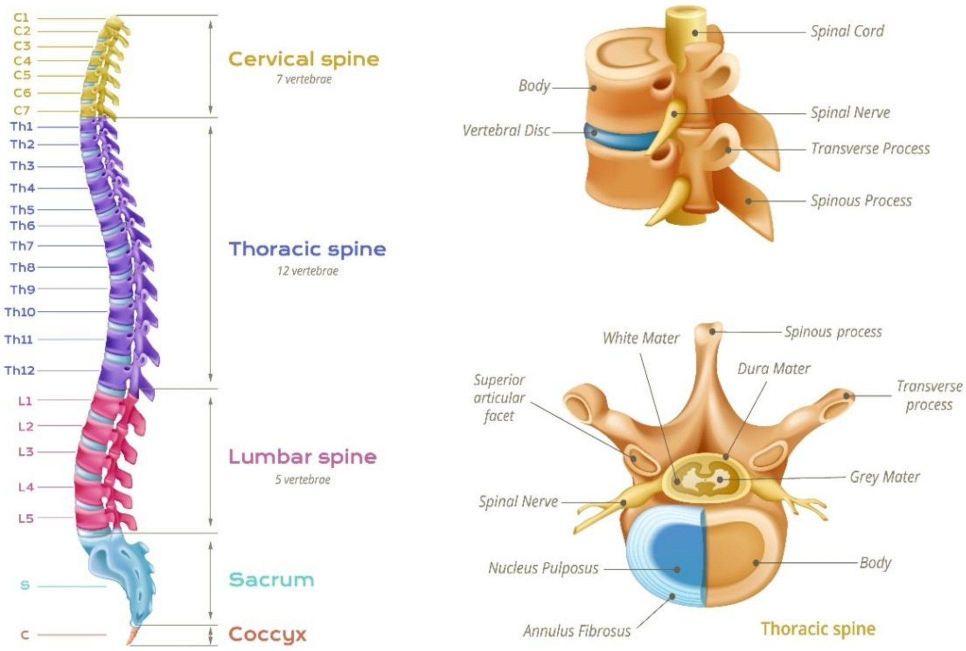


Fig 1: Anatomy of human vertebra

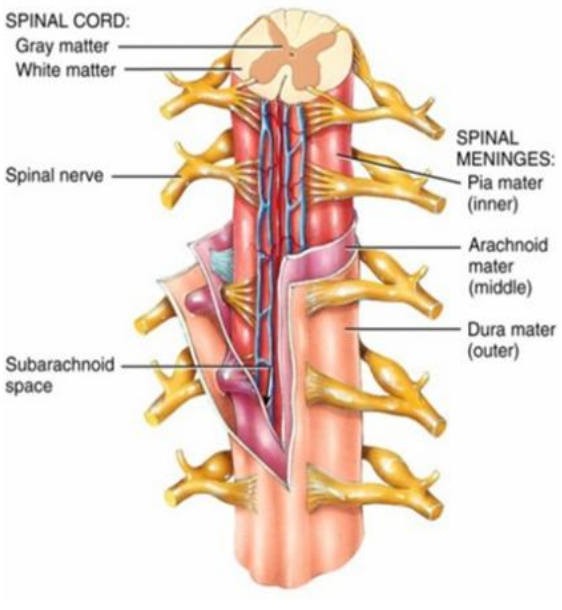
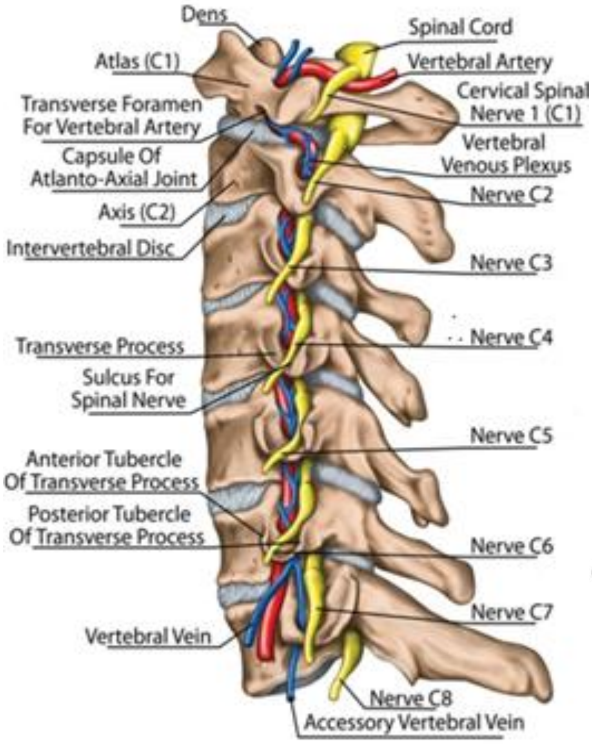


Fig 2: Anatomy of spinal cord



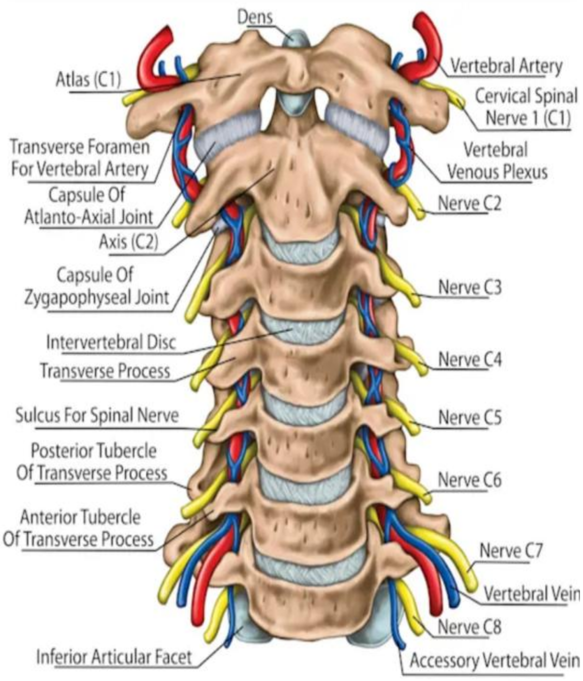


Fig 3(a) Fig 3(b)

Fig 3 (a,b): C-spine anatomy in sagittal (a) and coronal sections (b)

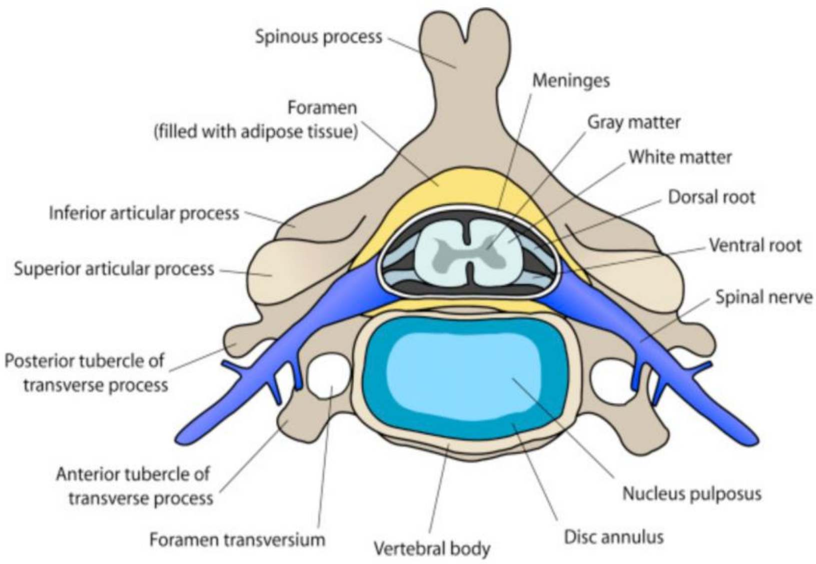


Fig 4: C-Spine anatomy in axial section with spinal cord and nerve roots

CERVICAL SPINAL STENOSIS

Cervical spinal stenosis occurs when nerve roots are compressed due to various pathological factors, resulting in symptoms such as pain, numbness, and weakness. This condition most commonly affects the cervical (upper neck) and lumbar (lower back) regions, though the thoracic spine can also be impacted, particularly by disc herniation. There are two primary anatomical sites within the cervical vertebral canal that can be affected by spinal stenosis:

1. **Central Canal**: This structure, which houses the spinal cord, can become narrowed in the anterior-posterior dimension. Such narrowing may compress neural elements and reduce the blood supply to the spinal cord in the cervical region or to the cauda equina in the lumbar region.
2. **Neural Foramen**: These openings allow nerve roots to exit the spinal cord. Compression in this area can occur due to disc herniation, hypertrophy of the facet joints and ligaments, or unstable slippage of one vertebral body over another.[1-3]

ETIOLOGY

The etiology of cervical spinal stenosis is divided into congenital or acquired.

Congenital etiologies include:

- Achondroplasia
- Anterior vertebral beaking or wedging
- Early vertebral arch ossification
- Thoracolumbar kyphosis
- Vertebral segmentation failure[11]

Acquired etiologies can be sub-classified into degenerative, systemic, infectious, traumatic, and iatrogenic and include:

- **Degenerative**
  - Disc degeneration
  - Hypertrophy of the facet joints
  - Hypertrophy of the ligamentum flavum
  - Ligamentum flavum ossification
  - Ligamentum flavum calcification
  - Posterior longitudinal ligament ossification
  - Stenosis secondary to disc herniation
  - Spondylolisthesis
  - Spondylosis
  - Scoliosis
- **Systemic**
  - Cushing syndrome
  - Acromegaly
  - Hyperparathyroidism
  - Ankylosing spondylitis
  - Paget's disease
- **Iatrogenic**
  - Previous spinal fusion
  - Previous spinal instrumentation

- **Infectious**
  - Osteomyelitis
- **Traumatic**[12-15]

Risk factors

- Rheumatoid Arthritis
- Osteoarthritis
- Degenerative Disc Disease
- Repetitive microtrauma
- Poor ergonomics[16]

Clinical presentation

Patients with cervical spinal canal and foraminal stenosis may be asymptomatic or present with neurological symptoms that include:

- Chronic neck pain
- Tingling and numbness
- Weakness of the upper limbs
- Arm or hand clumsiness
- Loss of hand dexterity
- Progressive loss of fine motor function of the hands
- Decreased or absent sensation of the arms or hands
- Gait abnormality
- Hyperreflexia
- Weakness of the lower extremities[16]

Pathophysiology

Cervical canal stenosis in the setting of age-related degeneration is mainly caused by:

- Intervertebral disc degeneration causing disc herniation and direct compression of the dural sac
- Facet joint degeneration causing joint instability and hypertrophy, which worsens the degree of dural sac compression[16,17]

Cervical neural foraminal stenosis is most commonly caused by :[18,19]

- Disc degeneration (reduced foraminal height, uncovertebral arthrosis) or facet joint arthropathy with disc herniation being a less common cause[18,19] . Other less common causes include tumors, trauma, tortuous vertebral artery, meningeal or synovial cysts[19].
- Capsule and ligament thickening, and osteophytic and cystic changes further worsen the degree of compression[18,19]

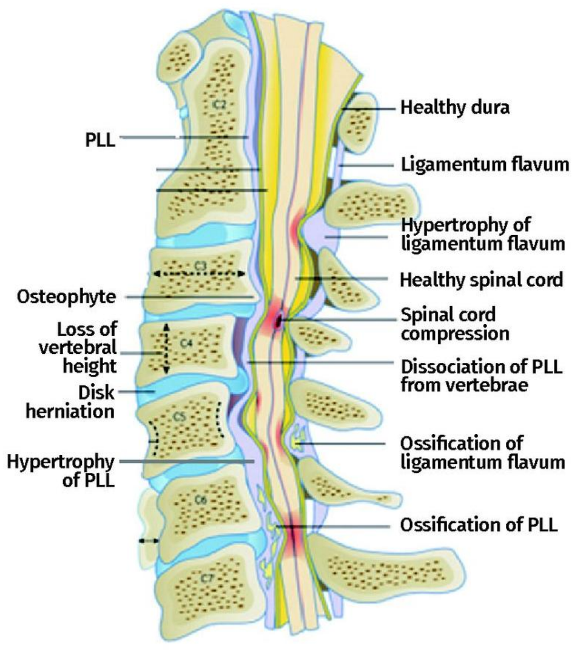


Fig 5: Degenerative causes of cervical myelopathy

RADIOLOGICAL FEATURES:

Cervical Spinal Canal Stenosis:

Plain radiograph

The canal-to-body ratio of Torg and Pavlov can be used to determine the presence of cervical canal stenosis.[20-22]

MRI

T1, T2-weighted sagittal and axial images can be used to look for cervical spinal canal stenosis based on the severity of spinal cord compression.

Cervical Neural Foraminal Stenosis:

MRI

Dedicated T2 FSE sagittal oblique sequences or sagittal oblique T2 SPACE reconstructions better delineate neural exit foramina.

Treatment and prognosis

Conservative management includes:[16,17]

- Physiotherapy
- Analgesics including paracetamol and nonsteroidal anti-inflammatory drugs
- Cervical spine bracing
- Corticosteroid injection
- Pulsed radiofrequency treatment

Operative management includes[16]

- Anterior approach discectomy or corporectomy
- Posterior approach laminectomy or laminoplasty.

For cervical foraminal stenosis, conservative options for acute and mild symptoms include analgesia and physiotherapy .[23,24] Transforaminal epidural steroid injection is considered second-line if conservative measures fail at 4-6 weeks [24] and are an effective treatment option but pain reduction may not be associated with the severity of foraminal stenosis [25.] Surgery (e.g. ACDF, cervical disc arthroplasty, posterior cervical foraminotomy) is indicated for severe symptoms or symptoms refractory to conservative treatments.[23,19]

Classification Systems

There are a number of proposed grading systems for cervical spinal canal and foraminal stenosis with excellent inter-reader correlation. Kang and Park grading systems for cervical spinal canal stenosis and neural foramina narrowing, correlates moderately to strongly with radicular symptoms in clinical settings, supporting its clinical relevance.

Park Grading System

The Park grading system, formulated by Park et al in 2013 is radiological classification designed to assess the degree of neural foraminal stenosis on MRI images of the cervical spine. The Park grading system is considered highly reproducible, especially due to its use of oblique sagittal T2-weighted MR images, which better align with the orientation of cervical neural foramina[25].

Kang Grading System

The Kang grading system, introduced by Kang et al in 2010 is a sagittal MRI-based classification focused on the degree of spinal canal compromise and spinal cord compression in the cervical region. It provides a clear scale for cord deformation and intramedullary signal change, which are critical indicators for surgical consideration in myelopathy. Signal changes on T2-weighted images in Grade 3 correlate with worse clinical outcomes, providing a radiologically meaningful marker for prognosis[19].

PREVIOUS STUDIES

Park et al. (2013)

This study examined the link between cervical neural foraminal stenosis, as graded by the park system, and clinical symptoms in 100 patients undergoing cervical spine MRI. Two musculoskeletal radiologists independently assessed stenosis severity, showing almost perfect interobserver agreement ($\kappa = 0.925$). A strong correlation was found between higher Park grades (2 or 3) and the presence of neurologic symptoms like pain (99%) and numbness (56%). Stenosis was most frequently found at C5–C6. The findings confirmed that the Park grading system is not only reproducible but also clinically meaningful, especially in patients over 50, as correlation remained strong across age groups.[25]

Rüegg et al. (2015)

This retrospective study focused on identifying MRI-based predictors of cervical spinal cord injury (CSCI) following minor trauma. Comparing 52 CSCI patients with 77 controls, it measured canal and cord dimensions to derive metrics like the cord-canal-area ratio and space available for the cord. These indicators had excellent diagnostic accuracy (AUC 0.99 and 0.98), effectively distinguishing injured from non-injured patients. However, no significant correlation was found between these metrics and motor function scores, meaning they help predict injury risk but not its severity or recovery.[6]

Schell et al. (2017)

In evaluating cervical foraminal stenosis on CT scans, this study assessed three imaging modalities—axial, 2D-SOMPR, and 3D reconstructions—in 25 surgical patients. Three reviewers graded foraminal narrowing severity, and interrater agreement was generally low ($\kappa < 0.4$), especially for axial images ($\kappa = 0.119$). However, 3D CT imaging yielded higher reliability ($\kappa = 0.334$) and better visualization. The authors concluded that 3D CT reconstructions, which don't require extra radiation or cost, should be used routinely for surgical evaluation due to improved consistency.[26]

Waheed et al. (2019)

This cross-sectional study evaluated 126 patients using Kang MRI grading to assess cervical canal stenosis and compare it with clinical symptoms. The results showed strong agreement between MRI findings and symptoms (K = 0.81), particularly in females, older individuals, and patients with longer symptom duration. These findings support Kang grading as a reliable diagnostic tool, capable of effectively capturing clinically significant stenosis.[4]

Chowdhury et al. (2021)

This study investigated the diagnostic value of cervical canal diameter (CCD) and space available for the cord (SAC) in both symptomatic and asymptomatic patients. CCD had a specificity of 91% and SAC 93%, with moderate sensitivity. When combined, the sensitivity improved to 82%, and negative predictive value rose to 90.6%, indicating the usefulness of both metrics in ruling out disease. A strong correlation between CAD and SAC was observed at the C7 level, reinforcing their value in evaluating cervical canal stenosis.[27]

Hutchins et al. (2023)

This pilot study introduced a novel MRI-compatible cervical compression device simulating the Spurling test in ten healthy individuals. Under compression, there was a significant increase in cervical lordosis and a notable decrease in foraminal cross-distance, though foraminal area changes weren't statistically significant. Image quality was preserved, and measurements showed excellent intraobserver and moderate interobserver reliability. The device shows potential for dynamic evaluation of foraminal narrowing in symptomatic patients during imaging.[28]

Cine et al. (2024)

Analyzing 557 ACDF surgery patients, this study used MRI grading of foraminal stenosis to assess surgical outcomes. Most patients had severe (grade 2) stenosis, and these patients showed the greatest reduction in pain and disability based on VAS and NDI scores. However, even those with milder stenosis improved significantly post-surgery. The study emphasizes the role of accurate MRI grading in guiding surgical decisions and predicting postoperative outcomes.[29]

MATERIALS & METHODS

MATERIALS AND METHODS

Study Design: Analytical observational study was conducted among patients referred for MRI of cervical spine for diagnostic evaluation to "department of Radiodiagnosis, R.L. Jalappa Hospital and Research Center, attached to Sri Devaraj Urs Medical College, Kolar, India"

Study Setting: A comprehensive study was conducted at the "Department of Radio-Diagnosis at R.L. Jalappa Hospital and Research Center attached to Sri Devaraj Urs Medical College, Kolar"

Study population: Patients referred for MRI of cervical spine for diagnostic evaluation of cervical SCS and NFS to R.L. Jalappa Hospital and Research Center

Study Duration: 12 months

Study Period: January 2024 to December 2024

Sample size estimation:

The sample size was estimated based on correlation coefficient (r) of MRI grade with neurological manifestations was found as 0.808 (i.e. r = 0.808) in cervical spinal stenosis from the study by Park HJ et al.[25]

The formula used was:

Sample size (n) = $[(Z_{1-\alpha/2}+Z_{\beta})/C]^2 + 3$

Where,

n = minimum number of cases required

$Z_{1-\alpha/2}$= 2.54 for 99% CI

Z_{β}= Standard normal deviate corresponding to the chosen power (90%) = 1.284

r: Correlation coefficient, r=0.808

C= 0.5 * ln[(1+r)/(1-r)]

Substituting all the values the C value obtained was 1.1221

Substituting all the above values in the formula the sample size obtained was 38, considering 10% non-response rate the final sample was 40

Sampling technique: Convenient sampling

ELIGIBILITY CRITERIA

Inclusion Criteria:

- All patients aged above 18 years undergoing MRI cervical spine presenting with one or more of the following:
    - Neck Pain
    - Radiating pain
    - Neck stiffness
    - Tingling
    - Numbness
    - Weakness
    - Loss of coordination
- Patients who gave written informed consent.

Exclusion criteria:

- Patients who are detected to have cervical spine fracture.
- Patients with spinal cord lesions.
- Post-operative patients.
- Patients with surgical implants.
- Patients with bony lesions.

- Patients with cardiac pacemakers.
- Claustrophobic patients.

Ethical clearance: Ethical clearance was obtained from Institutional Board of Central Ethics Committee, Sri Devaraj Urs Medical College, Kolar, India

Informed Consent: Before start of the study the purpose of the study was explained to the study participants and informed consent was obtained.

Sampling Procedure: 40 symptomatic patients referred for diagnostic evaluation of cervical SCS and NFS to "Department of Radio-Diagnosis at R.L. Jalappa Hospital and Research Center attached to Sri Devaraj Urs Medical College, Kolar, India" who met inclusion criteria of study and gave consent were included in the study.

Investigation and Interventions: Yes.

Demographics: Age distribution, gender of study participants were recorded.

Clinical investigations: Clinical symptoms were recorded

JOA Score and the **NDI** were utilized to assess the severity of the clinical symptoms and the degree of disability in patients with cervical spinal canal stenosis and cervical neural foraminal stenosis respectively.

Japanese Orthopedic Association score (JOA)

Criterion	Points
Motor function	
Paralysis	1
Upper extremity	
Fine motor function massively decreased	2
Fine motor function decelerated	3
Discreet weakness in hands or proximal arm	4
Normal function	5
Motor function	
Unable to walk	1
Lower extremity	
Need walking aid on flat floor	2
Need handrail on stairs	3
Able to walk without walking aid, but inadequate	4
Normal function	5
Sensory	
Upper extremity/lower extremity/trunk	
Apparent sensory loss	1
Minimal sensory loss	2
Normal function	3
Bladder function	
Urinary retention	1
Severe dysfunction	2
Mild dysfunction	3
Normal function	4
Total score	0–17

Myelopathy Severity Score	Severity
> 13	Mild
9 – 13	Moderate
< 9	Severe

NECK DISABILITY INDEX

This questionnaire is designed to help us better understand how your neck pain affects your ability to manage everyday-life activities. Please mark in each section the one box that applies to you, although you may consider that two of the statements in any one section relate to you. Please mark the box that **most closely** describes your present-day situation.

Section 1: Pain Intensity
- ☐ I have no neck pain at the moment.
- ☐ The pain is very mild at the moment.
- ☐ The pain is moderate at the moment.
- ☐ The pain is fairly severe at the moment.
- ☐ The pain is very severe at the moment.
- ☐ The pain is the worst imaginable at the moment.

Section 2: Personal Care
- ☐ I can look after myself normally without causing extra neck pain.
- ☐ I can look after myself normally, but it causes extra neck pain.
- ☐ It is painful to look after myself, and I am slow and careful
- ☐ I need some help but manage most of my personal care.
- ☐ I need help every day in most aspects of self -care.
- ☐ I do not get dressed. I wash with difficulty and stay in bed.

Section 3: Lifting
- ☐ I can lift heavy weights without causing extra neck pain.
- ☐ I can lift heavy weights, but it gives me extra neck pain.
- ☐ Neck pain prevents me from lifting heavy weights off the floor but I can manage if items are conveniently positioned, ie. on a table.
- ☐ Neck pain prevents me from lifting heavy weights, but I can manage light weights if they are conveniently positioned
- ☐ I can lift only very light weights.
- ☐ I cannot lift or carry anything at all.

Section 4: Work
- ☐ I can do as much work as I want.
- ☐ I can only do my usual work, but no more.
- ☐ I can do most of my usual work, but no more.
- ☐ I can't do my usual work.
- ☐ I can hardly do any work at all.
- ☐ I can't do any work at all.

Section 5: Headaches
- ☐ I have no headaches at all.
- ☐ I have slight headaches that come infrequently.
- ☐ I have moderate headaches that come infrequently.
- ☐ I have moderate headaches that come frequently.
- ☐ I have severe headaches that come frequently.
- ☐ I have headaches almost all the time.

Section 6: Concentration
- ☐ I can concentrate fully without difficulty.
- ☐ I can concentrate fully with slight difficulty.
- ☐ I have a fair degree of difficulty concentrating.
- ☐ I have a lot of difficulty concentrating.
- ☐ I have a great deal of difficulty concentrating.
- ☐ I can't concentrate at all.

Section 7: Sleeping
- ☐ I have no trouble sleeping.
- ☐ My sleep is slightly disturbed for less than 1 hour.
- ☐ My sleep is mildly disturbed for up to 1-2 hours.
- ☐ My sleep is moderately disturbed for up to 2-3 hours.
- ☐ My sleep is greatly disturbed for up to 3-5 hours.
- ☐ My sleep is completely disturbed for up to 5-7 hours.

Section 8: Driving
- ☐ I can drive my car without neck pain.
- ☐ I can drive my car with only slight neck pain.
- ☐ I can drive as long as I want with moderate neck pain.
- ☐ I can't drive as long as I want because of moderate neck pain.
- ☐ I can hardly drive at all because of severe neck pain.
- ☐ I can't drive my car at all because of neck pain.

Section 9: Reading
- ☐ I can read as much as I want with no neck pain.
- ☐ I can read as much as I want with slight neck pain.
- ☐ I can read as much as I want with moderate neck pain.
- ☐ I can't read as much as I want because of moderate neck pain.
- ☐ I can't read as much as I want because of severe neck pain.
- ☐ I can't read at all.

Section 10: Recreation
- ☐ I have no neck pain during all recreational activities.
- ☐ I have some neck pain with all recreational activities.
- ☐ I have some neck pain with a few recreational activities.
- ☐ I have neck pain with most recreational activities.
- ☐ I can hardly do recreational activities due to neck pain.
- ☐ I can't do any recreational activities due to neck pain.

Patient Name ______________________ Date __________

Score __________ [50]

Score	Severity of disability
0 - 4	No disability
5 - 14	Mild disability
15 - 24	Moderate disability
25 – 34	Severe disability
35 - 50	Complete disability

Radiological investigations: MRI of cervical spine

MRI Grading Systems

Kang et al. Grading System was used to assess the degree of cervical canal stenosis

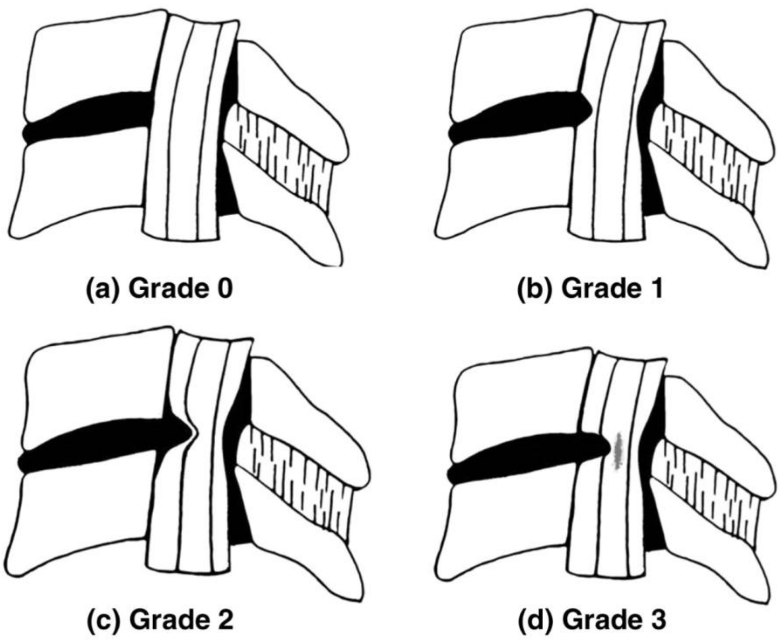


Fig 6: Schematic diagram of Kang grading system for cervical canal stenosis in sagittal sections of cervical spine.

(A) Grade 0 - Normal.

(B) Grade 1 - Obliteration of more than 50% of subarachnoid space without any sign of cord deformity.

(C) Grade 2 - Central canal stenosis with spinal cord deformity; cord is deformed but no signal change in spinal cord.

(D) Grade 3 - Increased signal intensity of spinal cord near compressed level on T2-weighted images.

Park et al. Grading System for Cervical Foraminal Stenosis

The **Park et al. Grading System** was used to evaluate the severity of cervical foraminal stenosis. This grading system was based on the degree of foraminal narrowing observed on MRI, which can impinge upon nerve roots.

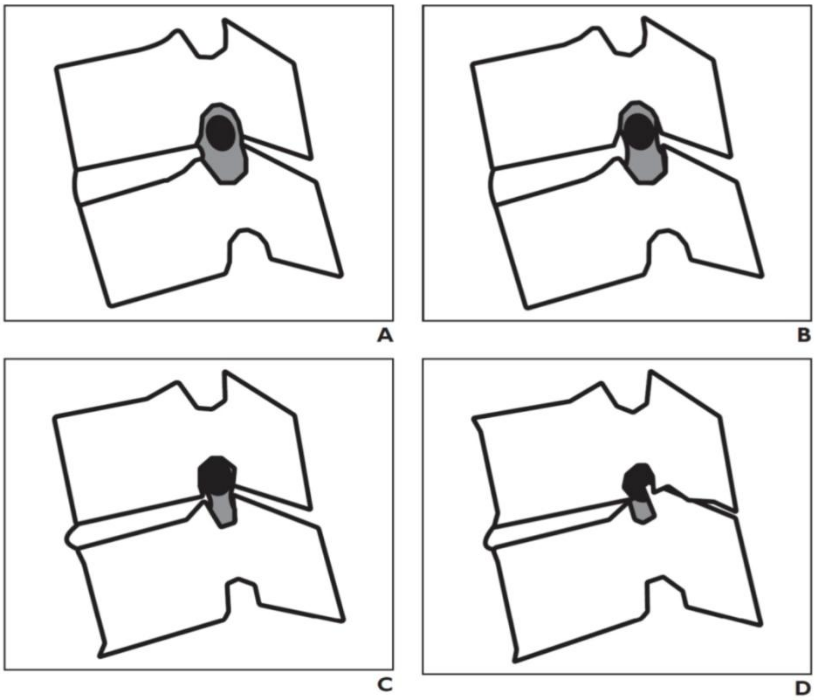


Fig 7: Schematic diagram of Park grading system for cervical neural foraminal stenosis in oblique sagittal sections of cervical spine.

(A) Grade 0 - Oblique sagittal plane showing no significant stenosis and no perineural fat obliteration.

(B) Grade 1 - Mild perineural fat obliteration.

(C) Grade 2 - Moderate perineural fat obliteration without morphological change of nerve root.

(D) Grade 3 - Severe perineural fat obliteration with collapsed nerve root and morphologic changes.

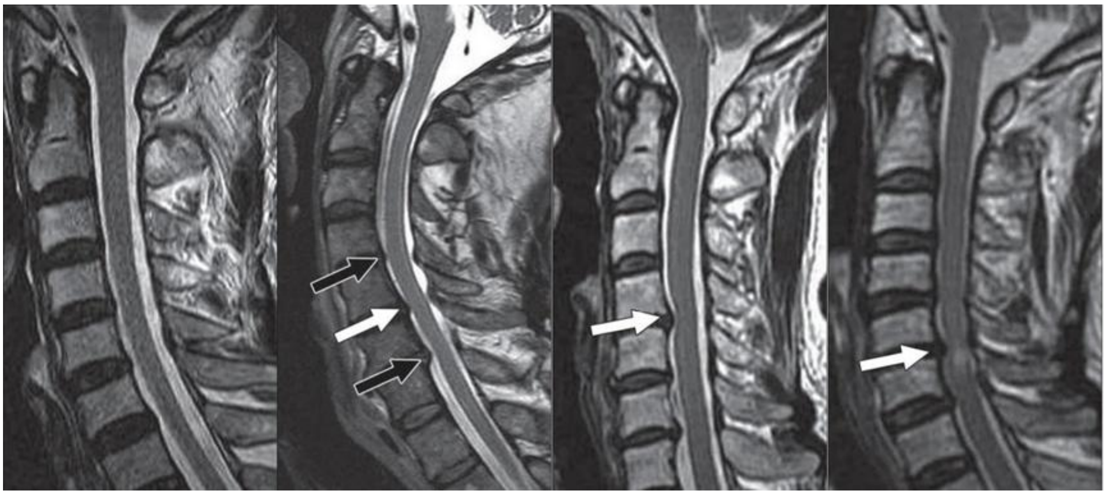


Fig 8 : From left to right, T2 W sagittal images of C-spine demonstrating Grade 0, Grade 1, Grade 2 and Grade 3 cervical spinal canal stenosis (Kang grading system)

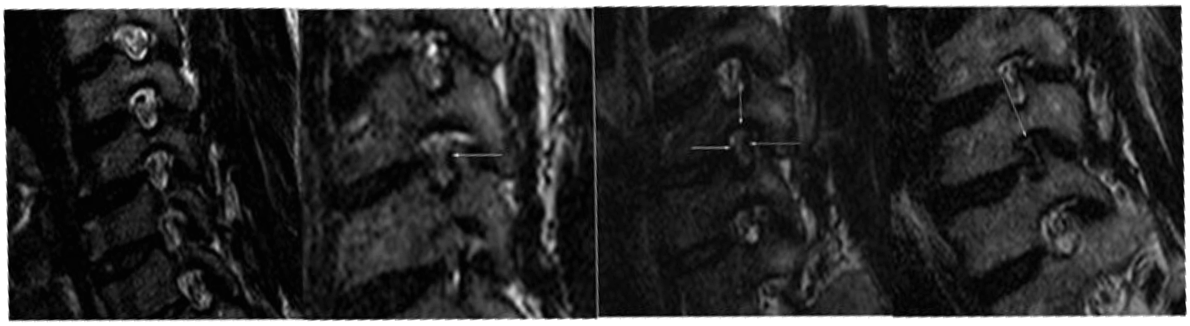


Fig 9 : From left to right, T2 W oblique sagittal images of C-spine demonstrating Grade 0, Grade 1, Grade 2 and Grade 3 of cervical neural foraminal stenosis (Park grading system)

BRIEF OVERVIEW OF THE MRI PROCEDURE FOR CERVICAL SPINE EVALUATION:

In this study, MRI of the cervical spine was used as the primary radiographic investigation to assess the degree of cervical spinal canal stenosis and foraminal stenosis. The MRI procedure provides detailed imaging of the cervical vertebrae, IVD, spinal cord, and nerve roots, which is essential for evaluating the extent of stenosis. The MRI protocol used in this study includes standard sequences to evaluate both the cervical canal and neural foramina.

MRI Procedure

1. **Patient Preparation:**
    - Prior to the MRI procedure, the patient is informed about the nature of the study and the potential risks associated with magnetic resonance imaging (MRI). Consent is obtained from the patient to ensure ethical compliance.
    - Patients are asked to remove any metal objects, including jewellery, watches, and hearing aids, as these can interfere with the MRI process.
    - The patient is positioned in a supine position on the MRI table, with their head secured in a headrest to minimize movement during the scan.
2. **MRI Machine and Settings:**
    - **MRI Scanner**: The MRI evaluation is conducted using a 1.5 Tesla, 18-channel MRI scanner (Siemens® Magnetom Avanto®).
    - **Sequences Used**: The following MRI sequences are performed to assess the cervical spine:
        - **T2-weighted (T2W) sagittal sequences**: These sequences offer better visualization of soft tissue structures, including the spinal cord and intervertebral discs. They are

crucial for assessing abnormalities such as disc herniations, spinal canal narrowing, and the degree of stenosis.

- **Oblique sagittal T2W sequences**: In addition to the standard T2W sagittal images, additional oblique sagittal reformatted sequences in 45^0 angle are used to evaluate the cervical neural foramina in detail. This is particularly important for assessing foraminal stenosis, where the nerve roots may be compressed due to narrowing of the foraminal openings.

3. **Image Acquisition:**
   - The MRI sequences are obtained in a stepwise fashion to ensure thorough assessment of both the cervical canal and the neural foramina.
   - **Scan Duration**: The MRI scan typically takes between 20 to 30 minutes.
   - **Post-processing**: After image acquisition, post-processing is performed to generate high-quality images, including multiplanar reconstructions (MPR), which allow for more comprehensive evaluation of the spinal structures.
4. **Radiological Interpretation:**
   - The images are assessed for the presence and degree of cervical canal stenosis and foraminal stenosis, which are graded using the Kang et al. and Park et al. grading systems, respectively.

METHOD OF DATA COLLECTION:

Following the explanation of the study's purpose and the assurance of confidentiality and anonymity, 40 symptomatic patients clinically diagnosed with cervical canal stenosis and/or cervical foraminal stenosis, who attended the Department of Radio Diagnosis at R.L. Jalappa Hospital and Research Center, Sri Devaraj Urs Medical College, Kolar, India, were enrolled in the study after fulfilling the inclusion criteria and providing written consent. Demographic information, encompassing age distribution and gender, was documented. Clinical symptoms were evaluated with JOA Score and NDI to determine the extent of neurological impairment and functional disability resulting from neck discomfort, with grading based on the scores obtained. JOA was employed for assessing cervical spinal canal stenosis, while NDI was utilized for evaluating cervical neural foraminal stenosis. An MRI of the cervical spine was performed, utilizing grading systems to evaluate the severity of stenosis: the Kang et al. Grading System for cervical canal stenosis, which classifies stenosis into four grades ranging from normal to severe, and the Park et al. Grading System for cervical foraminal stenosis, which categorizes stenosis into four grades from normal to severe based on foraminal narrowing and nerve root compression. The gathered data, encompassing demographics, clinical characteristics, and radiographic results, were input into Excel and analyzed statistically to assess correlations between these variables and the severity of stenosis.

Statistical Analysis

The collected data was entered into MS Excel and checked for completeness. The collected data was analysed using Statistical Package for Social Sciences version 28.0 (SPSS V 28). Descriptive statistics were obtained as means and standard deviation for continuous variables and frequency and percentage for categorical variables. Pearsons correlation was performed. P value ≤ 0.05 was considered statistically significant.

RESULTS

RESULTS

TABLE 1: AGE DISTRIBUTION AMONG STUDY PARTICIPANTS

AGE	FREQUENCY	PERCENTAGE
≤30	4	10
31-40	5	12.5
41-50	10	25
51-60	13	32.5
>60	8	20
MEAN±SD	50.2 ± 12.962	

GRAPH 1 (Fig 10): AGE DISTRIBUTION AMONG STUDY PARTICIPANTS

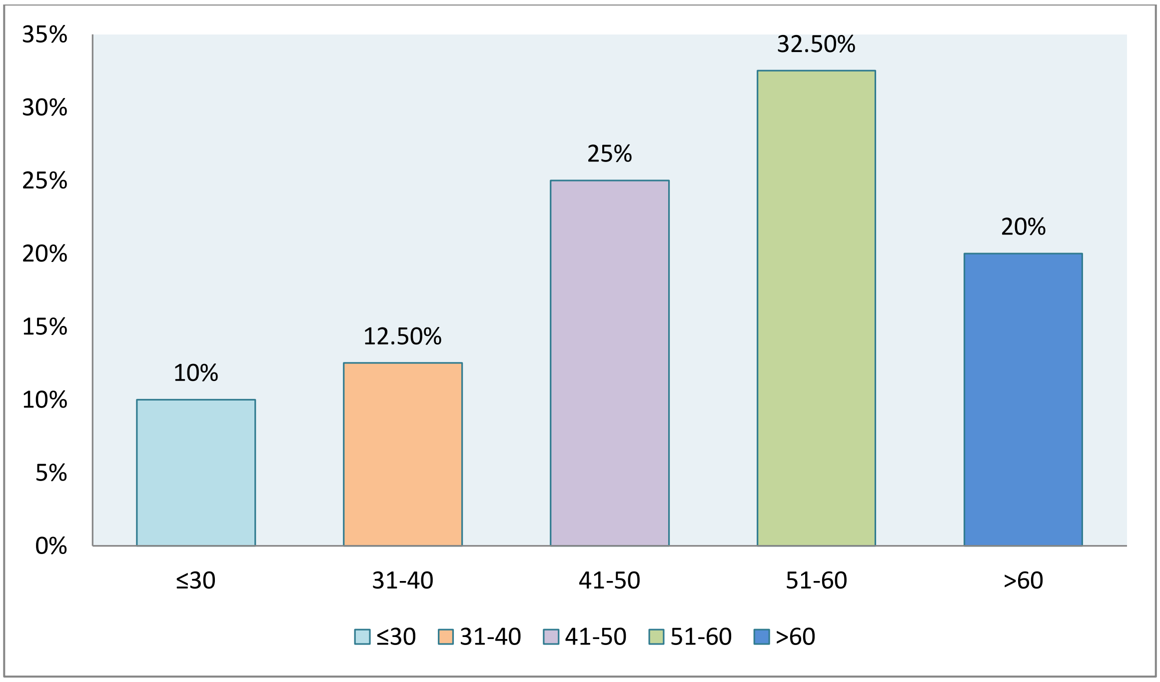


Table 1 and Graph 1 provides thorough information of the study participants age distribution. Comprising 32.5% (n=13) of the whole study population, most of the individuals fell between the age of 51 - 60. Following this, 25% (n=10) of them were in 41–50 age group, 20% (n=8) of individuals are above 60 years age group. Participants ranging in age between 31–40 accounted for 12.5% (n=5). While the youngest age group (≤30 years) constituted 10% (n=4), The mean age of the study population was 50.2 ± 12.962 years.

TABLE 2: GENDER DISTRIBUTION AMONG STUDY PARTICIPANTS

GENDER	FREQUENCY	PERCENTAGE
MALE	19	47.5
FEMALE	21	52.5

GRAPH 2 (Fig 11): GENDER DISTRIBUTION AMONG STUDY PARTICIPANTS

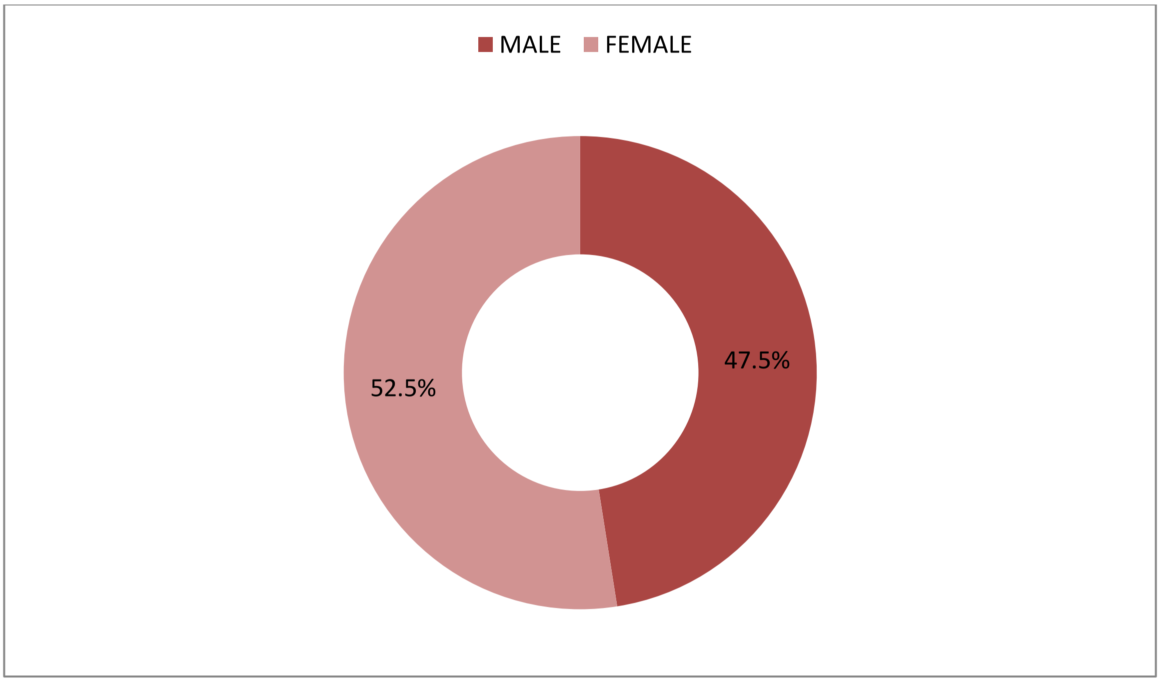


Table 2 and Graph 2 shows the gender distribution of the study subjects. Of the forty participants, 52.5% were female and 47.5% were male.

TABLE 3: NUMBER OF DISC LEVELS AFFECTED AMONG STUDY PARTICIPANTS

NUMBER OF DISC LEVELS	FREQUENCY	PERCENTAGE
1	15	37.5
2	8	20
3	10	25
4	5	12.5
5	2	5

GRAPH 3 (Fig 12): NUMBER OF DISC LEVELS AFFECTED AMONG STUDY PARTICIPANTS

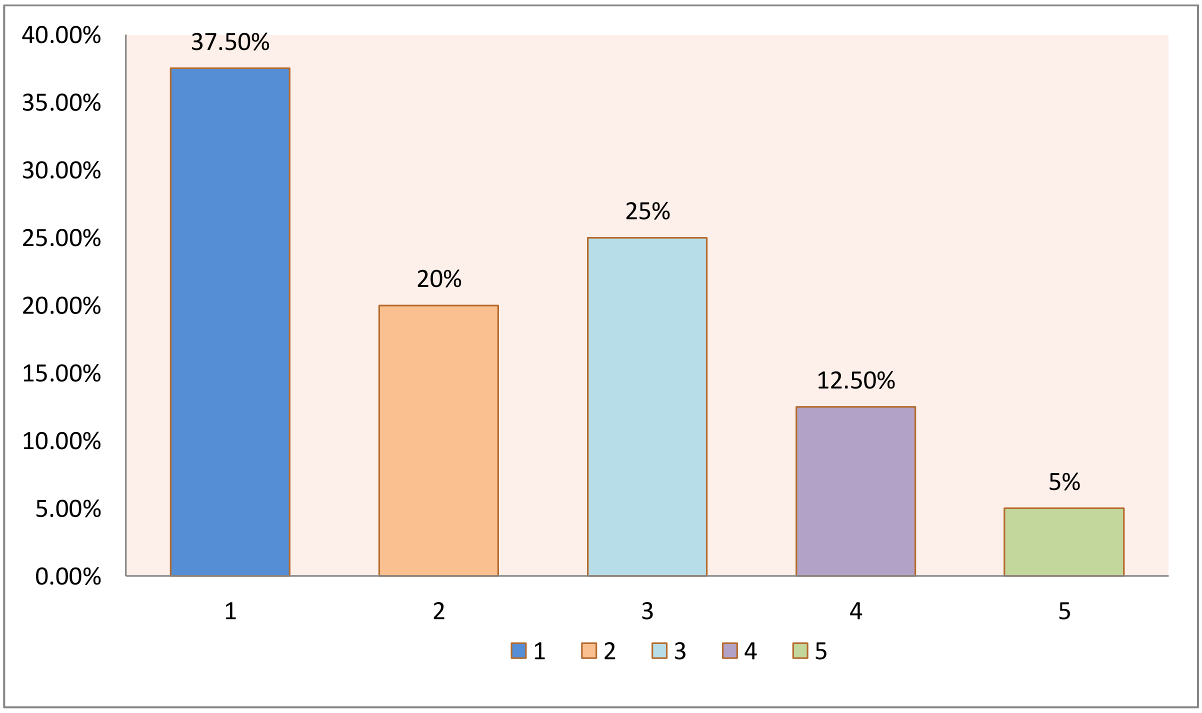


Table 3 and Graph 3 illustrates the distribution of affected disc levels among the study participants. The majority of participants (37.5%) exhibited involvement of a single disc level whereas 25% demonstrated involvement of three disc levels and 20% demonstrated involvement of two disc levels . A minority of subjects exhibited four (12.5%) and five (5%) impaired disc levels.

TABLE 4: DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C2-C3 LEVEL

C2-C3	KANG SYSTEM		PARK SYSTEM	
	NO: OF PATIENTS	PERCENTAGE	NO: OF PATIENTS	PERCENTAGE
GRADE 0	35	87.5	38	95
GRADE I	4	10	2	5
GRADE II	1	2.5	0	0
GRADE III	0	0	0	0

GRAPH 4 (Fig 13): DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C2-C3 LEVEL

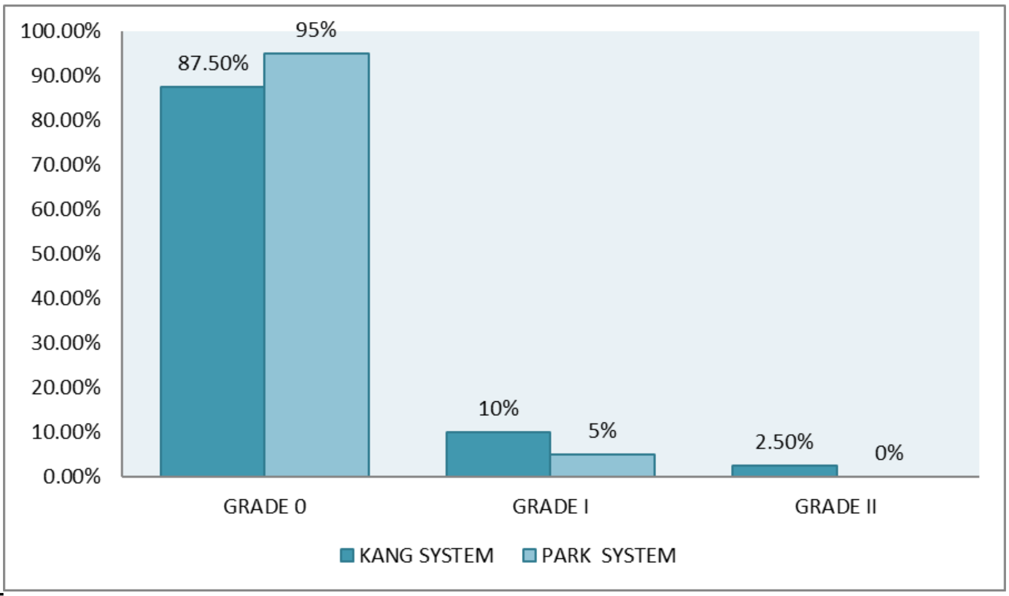


Table 4 and Graph 4 represents the distribution of subjects according to the Kang and Park grading systems at the C2–C3 level. In the Kang system (spinal canal stenosis), the majority of subjects (87.5%) were classified as Grade 0, followed by 10% in Grade I and 2.5% in Grade II, with no subjects in Grade III. Similarly, the Park system (neural foraminal stenosis) showed 95% of subjects in Grade 0 and 5% in Grade I, with no cases falling under Grades II or III.

TABLE 5: DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C3-C4 LEVEL

C3-C4	KANG SYSTEM		PARK SYSTEM	
	NO:OF PATIENTS	PERCENTAGE	NO:OF PATIENTS	PERCENTAGE
GRADE 0	28	70	25	62.5
GRADE I	8	20	9	22.5
GRADE II	3	7.5	4	10
GRADE III	1	2.5	2	5

GRAPH 5 (Fig 14): DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C3-4 LEVEL

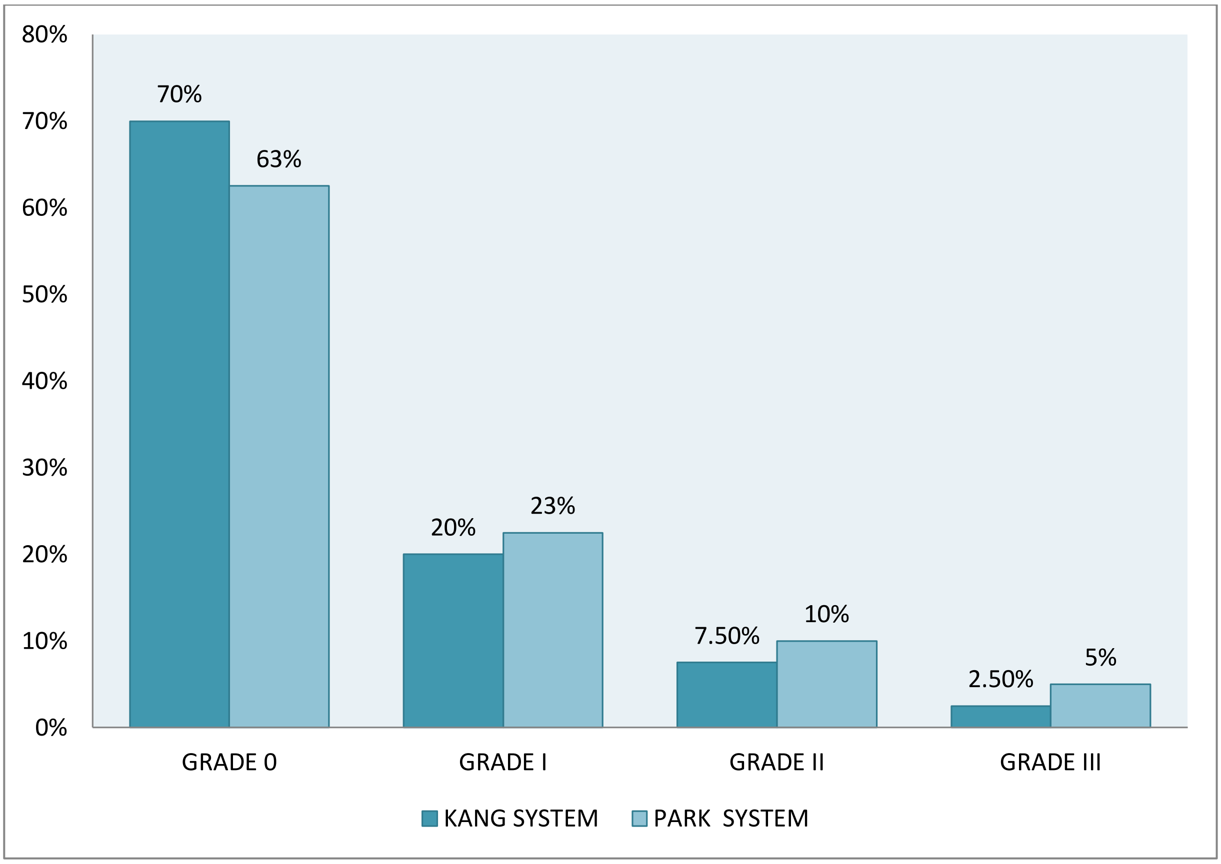


Table 5 and Graph 5 shows the distribution of subjects based on the Kang and Park grading systems at C3–C4 level. According to the Kang system, 70% of subjects were graded as Grade 0, followed by 20% in Grade I, 7.5% in Grade II, and 2.5% in Grade III. In comparison, the Park system recorded 63 % of subjects in Grade 0, but a slightly greater distribution in higher grades: 23%, 10% and 5% each in Grades I, II, and III.

TABLE 6: DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C4-C5 LEVEL

C4-C5	KANG SYSTEM		PARK SYSTEM	
	NO: OF PATIENTS	PERCENTAGE	NO: OF PATIENTS	PERCENTAGE
GRADE 0	20	50	16	40
GRADE I	10	25	12	30
GRADE II	8	20	8	20
GRADE III	2	5	4	10

GRAPH 6 (Fig 15): DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEM AT C4-C5LEVEL

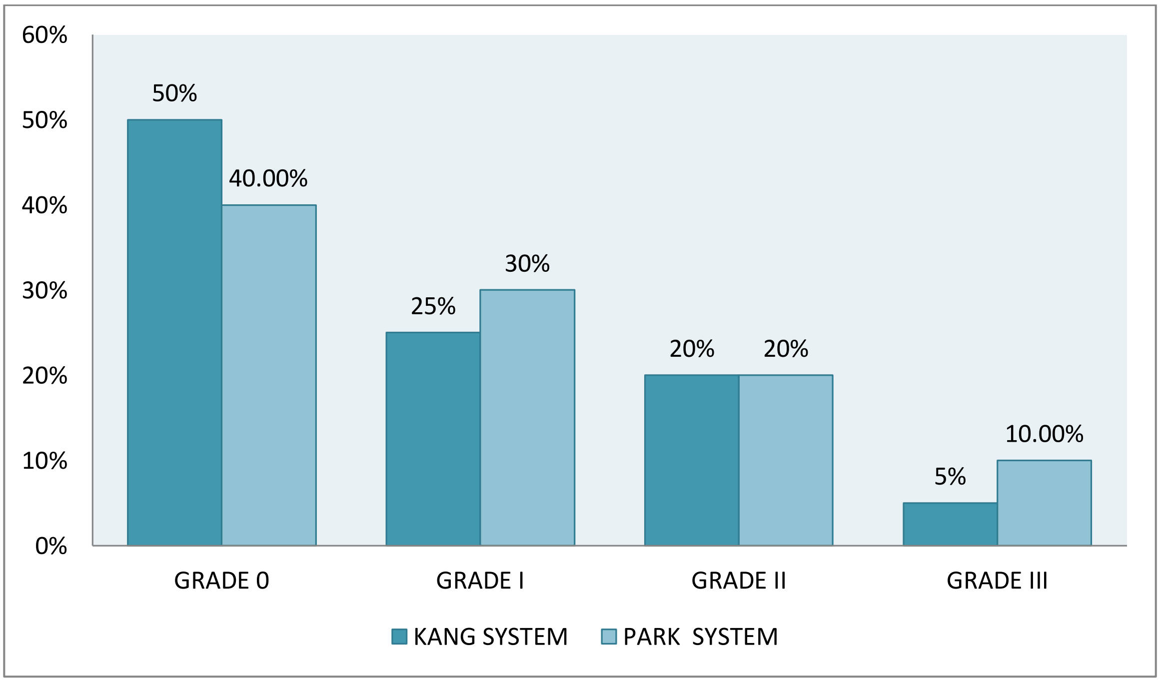


Table 6 and Graph 6 represents the distribution of subjects according to the Kang and Park grading systems at the C4–C5 level. As per the Kang system, 50% of the subjects were classified as Grade 0, followed by 25% in Grade I, 20% in Grade II, and 5% in Grade III. In contrast, the Park system showed 40 % of subjects in Grade 0, 30 % in Grade I, 20 % in Grade II, and a notably higher proportion (10%) in Grade III compared to superior levels.

TABLE 7: DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C5-C6 LEVEL

C5-C6	KANG SYSTEM		PARK SYSTEM	
	NO:OF PATIENTS	PERCENTAGE	NO:OF PATIENTS	PERCENTAGE
GRADE 0	12	30	7	17.5
GRADE I	13	32.5	14	35
GRADE II	8	20	10	25
GRADE III	7	17.5	9	22.5

GRAPH 7 (Fig 16): DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C5-C6 LEVEL

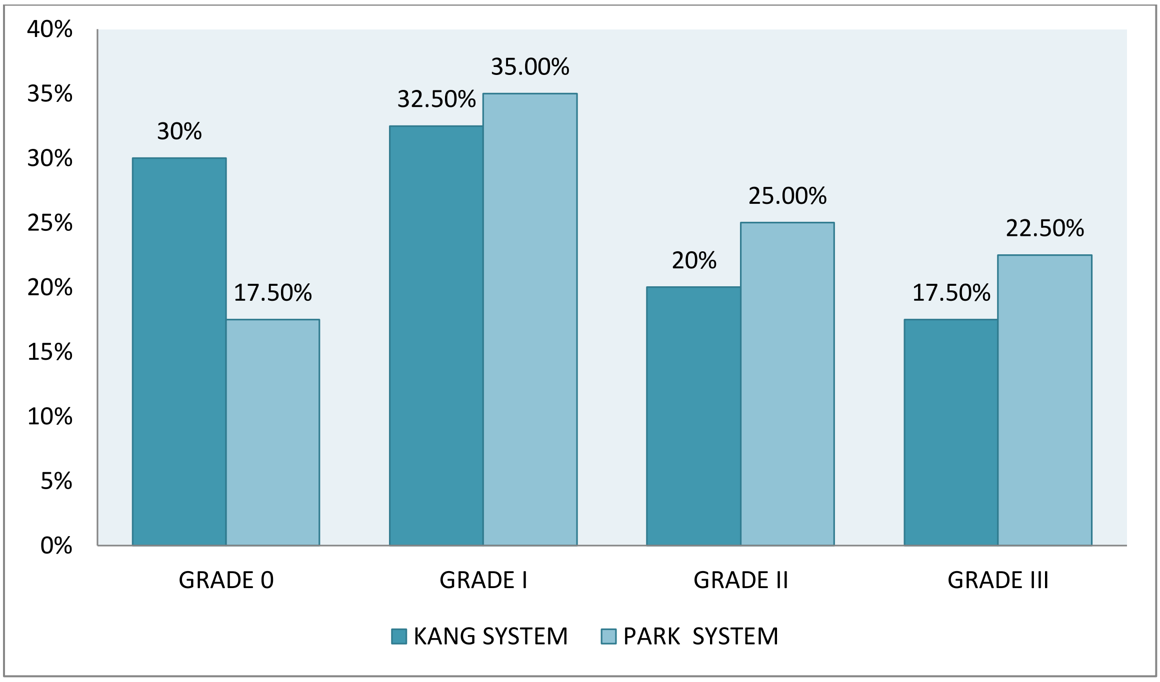


Table 7 and Graph 7 demonstrates the distribution of subjects as per the Kang and Park grading systems at the C5–C6 level. According to the Kang system, 30% of subjects were graded as Grade 0, 32.5% as Grade I, 20 % as Grade II, and 22.5 % as Grade III, indicating relatively higher severity compared to superior levels. According to park grading system, 35% were under grade I, 25% of subjects were under Grade II, 22.5 % under grade III, indicating relatively higher severity compared to superior levels

TABLE 8: DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C6-C7 LEVEL

C6-C7	KANG SYSTEM		PARK SYSTEM	
	NO:OF PATIENTS	PERCENTAGE	NO:OF PATIENTS	PERCENTAGE
GRADE 0	15	37.5	10	25
GRADE I	12	30	13	32.5
GRADE II	9	22.5	10	25
GRADE III	4	10	7	17.5

GRAPH 8 (Fig 17): DISTRIBUTION OF SUBJECTS AS PER KANG (SPINAL CANAL STENOSIS) & PARK (NEURAL FORAMINAL STENOSIS) GRADING SYSTEMS AT C6-C7 LEVEL.

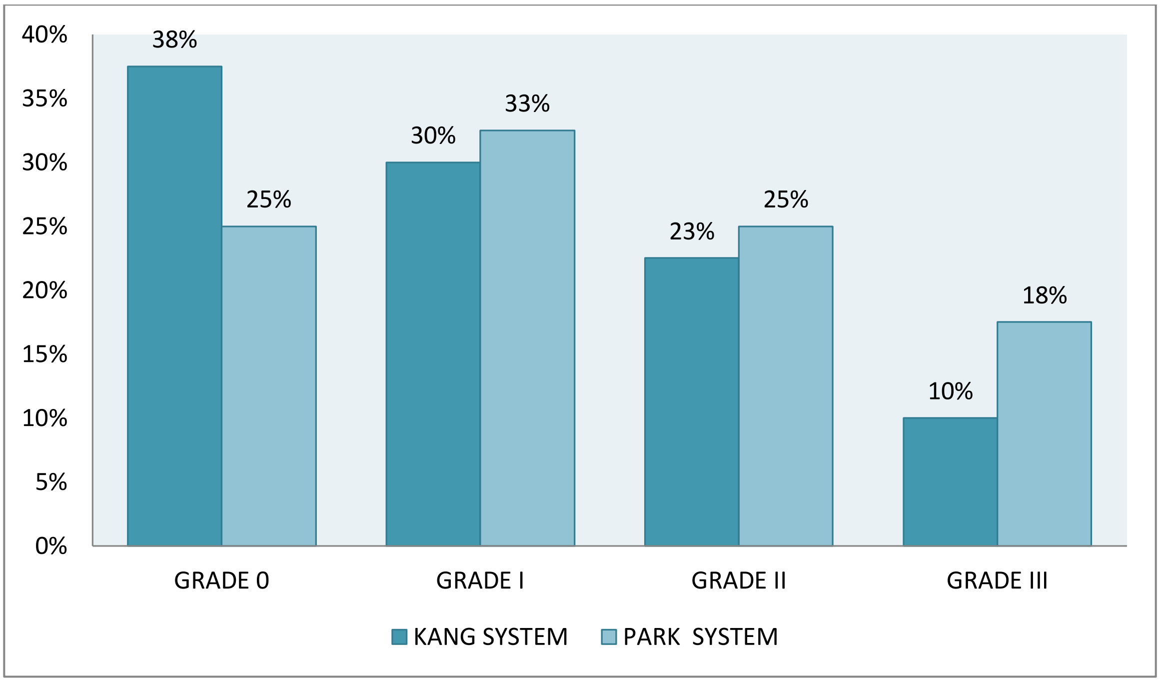


Table 8 and Graph 8 represents the distribution of subjects based on the Kang and Park grading systems at the C6–C7 level. According to the Kang system, 38% of subjects were classified as Grade 0, 30% as Grade I, 23% as Grade II, and 10% as Grade III, indicating that the majority exhibited either no stenosis or mild to moderate changes. The Park system for neural foramina stenosis, in contrast to C5-6 level reported lesser severity (grade III – 18%)

TABLE 9: KANG GRADING SYSTEM (SPINAL CANAL STENOSIS) (GRADE 0-III) AT ALL THE CERVICAL DISC LEVELS AMONG STUDY PARTICIPANTS

Variables	GRADE 0		GRADE I		GRADE II		GRADE III	
	N	%	N	%	N	%	N	%
C2-C3	35	87.5	4	10	1	2.5	0	0
C3-C4	28	70	8	20	3	7.5	1	2.5
C4-C5	20	50	10	25	8	20	2	5
C5-C6	12	30	13	32.5	8	20	7	17.5
C6-C7	15	37.5	12	30	9	22.5	4	10

GRAPH 9 (Fig 18): KANG GRADING SYSTEM (SPINAL CANAL STENOSIS) (GRADE 0-III) AT ALL THE CERVICAL DISC LEVELS AMONG STUDY PARTICIPANTS

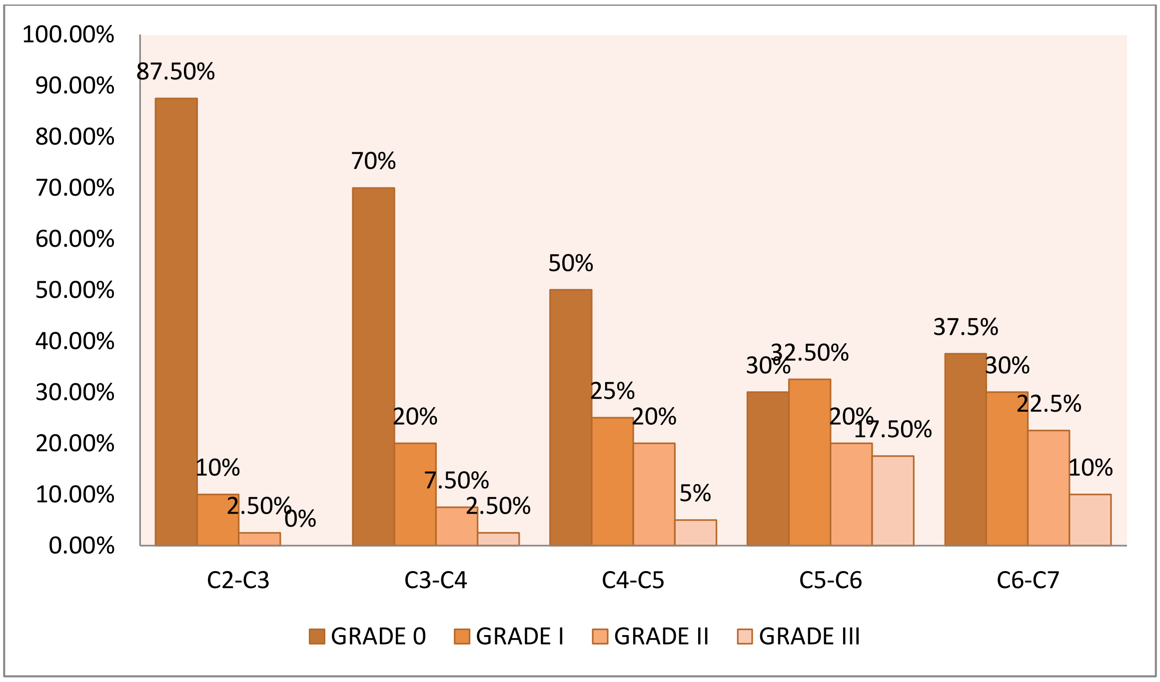


Table 9 and Graph 9 delineates the classification of cervical spinal canal stenosis in accordance with the Kang grading system across different cervical levels (C2–C7). At the C2–C3 level, the majority of patients (87.5%) exhibited Grade 0 findings, with minimal involvement at Grade I (10%) and Grade II (2.5%). There were no instances of Grade III stenosis at this level. A similar pattern was observed at C3–C4, where Grade 0 was noted in 70% of participants, followed by Grade I in 20%, Grade II in 7.5%, and Grade III in only 2.5%. A progressive increase in the severity of spinal canal stenosis was seen in lower cervical levels. At C4–C5, Grade 0 findings declined to 50%, with increased occurrences of Grade I (25%), Grade II (20%), and Grade III (5%). This trend continued at C5–C6, where only 30% had Grade 0, while higher-grade stenosis was more common: Grade I in 32.5%, Grade II in 20%, and Grade III in 17.5%. The C6–C7 level also showed significant stenotic changes, with Grade I and Grade II each accounting for 30% and 22.5% respectively, and Grade III present in 10% of patients.

TABLE 10: PARK GRADING SYSTEM (NEURAL FORAMINAL STENOSIS) (GRADE 0-III) AT ALL THE CERVICAL DISC LEVELS AMONG STUDY PARTICIPANTS

Variables	GRADE 0		GRADE I		GRADE II		GRADE III	
	N	%	N	%	N	%	N	%
C2-C3	38	95	2	5	0	0	0	0
C3-C4	25	62.5	9	22.5	4	10	2	5
C4-C5	16	40	12	30	8	20	4	10
C5-C6	7	17.5	14	35	10	25	9	22.5
C6-C7	10	25	13	32.5	10	25	7	17.5

GRAPH 10 (Fig 19): PARK GRADING SYSTEM (NEURAL FORAMINAL STENOSIS) (GRADE 0-III) AT ALL THE CERVICAL DISC LEVELS AMONG STUDY PARTICIPANTS

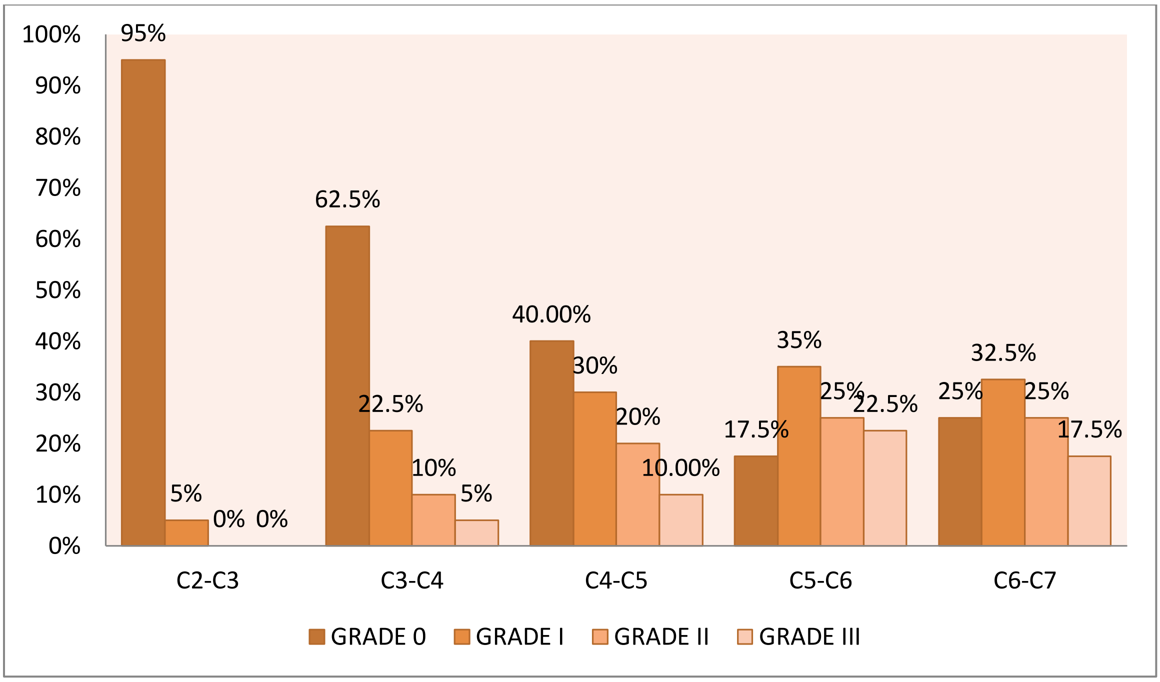


Table 10 and Graph 10 illustrates, using the Park grading system (Grade 0 to III), the degree of neural foraminal constriction among the research participants spanning cervical levels C2- C7. At the C2–C3 level, the vast majority of patients (95%) demonstrated Grade 0 (no stenosis), with only 5% showing Grade I narrowing and no higher-grade involvement. Similarly, at C3–C4, Grade 0 changes were most common (62.5%), though higher-grade stenosis was noted in a small subset: Grade I in 22.5%, Grade II in 10%, and Grade III in 5%. Progressing caudally, the prevalence of higher-grade stenosis increased. At C4–C5, only 40% had Grade 0, while Grade I was present in 30%, Grade II in 20%, and Grade III in 10% of cases. This trend continued at C5–C6, where only 17.5% of patients showed Grade 0, and the distribution shifted significantly toward more severe stenosis: Grade I in 35%, Grade II in 25%, and Grade III in 22.5%. At the C6–C7 level, Grade I was most common (32.5%), followed by Grade 0 and Grade II (each 25%), and Grade III in 17.5% of patients.

TABLE 11: CORRELATION BETWEEN KANG GRADING SYSTEM AND JAPANESE ORTHOPAEDIC ASSOCIATION (JOA) SCORE

KANG GRADING SYSTEM	**JAPANESE ORTHOPAEDIC ASSOCIATION (JOA) SCORE**	
	r-Value	-0.949
	P-Value	<0.001

Pearsons correlation

P≤0.05 is statistically significant

As shown in Table 11, Pearson’s correlation analysis revealed strong negative correlation between the Kang grading system for spinal canal stenosis and the Japanese Orthopaedic Association (JOA) score, with an r-value of –0.949 and a p-value of <0.001, indicating high statistical significance (p ≤ 0.05).

TABLE 12: CORRELATION BETWEEN PARK GRADING SYSTEM AND NECK DISABILITY INDEX (NDI)

	NECK DISABILITY INDEX (NDI)	
PARK GRADING SYSTEM	r-Value	0.879
	P-Value	<0.001

Pearsons correlation

$P \leq 0.05$ is statistically significant0000000

As demonstrated in Table 12, Pearson's correlation analysis revealed strong positive correlation between the Park grading system for neural foraminal stenosis and the Neck Disability Index (NDI) score, with an r-value of 0.879 and a p-value of <0.001, indicating high statistical significance ($p \leq 0.05$).

CASE 1

Fig 20 (a) **Fig 20 (b)**

Fig 20 : Mri C-spine sagittal T2W image(a) and oblique sagittal T2W image(b) of a patient demonstrating Grade II spinal canal stenosis (Kang system) at C3-4, C5-6 and C6-7 levels and Grade III neural foraminal stenosis at C5-6 and C6-7 levels respectively. JOA and NDI score of the patient were 11 and 28 respectively.

CASE 2:

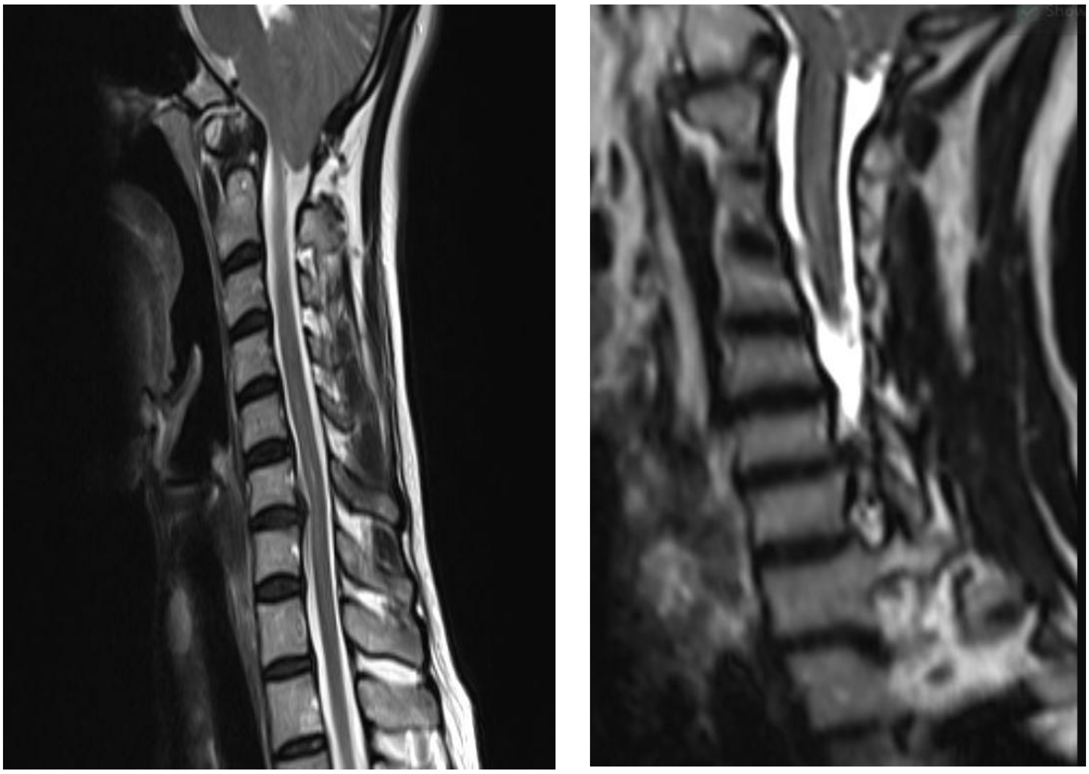


Fig 21 (a) **Fig 21 (b)**

Fig 21: Mri C-spine saggital T2W image(a) and oblique sagittal T2W image(b) of a patient demonstrating Grade III spinal canal stenosis (Kang system) at C6-7 level and Grade II neural foraminal stenosis at C6-7 level respectively. JOA and NDI score of the patient were 7 and 17 respectively.

DISCUSSION

Magnetic resonance imaging (MRI) of the cervical spine is essential for evaluating cervical neural foraminal stenosis (NFS) and cervical spinal canal stenosis (SCS). A comprehensive clinical history and physical examination are crucial for assessing patients with suspected cervical spinal stenosis, while contemporary imaging, particularly MRI, provides precise insights into the extent and nature of the pathology and offers definitive confirmation.

This study categorized each participant into one of four groups according to the levels of SCS and NFS, utilizing established standardized grading systems from prior studies.[25,30,31] These grades are clinically meaningful and inform treatment decisions. Grade III stenosis and higher grades typically associate with inferior clinical results and diminished responsiveness to decompression operations.[28,32-34]

Takahashi et al. supporting this noted that patients with Grade III stenosis had more marked neurological impairments and a less favourable prognosis, therefore clearly linking the degree of spinal cord compression to clinical symptom severity.[35] Sun et al. similarly underlined the significance of NFS grading and its applicability in deciding whether additional uncinate process resections during anterior cervical discectomy and fusion are needed.[36]

The current study revealed a mean participant age of 50.2 ± 12.96 years, which is somewhat lower than the findings of Po I et al. (56.1 ± 10.87 years), Ko S et al. (54.3 years), Marc Hohenhaus et al. (58 years), and Kang et al. (65.2 years).[20,30,37,38] Nonetheless, it is analogous to the results of Waheed H et al. (50.3 ± 14.3 years) and somewhat exceeds the average age documented by Kini et al. (46 ± 13.02 years).[4,39]

The disparity in age distribution among studies may indicate demographic variations or differing sampling techniques; still, the overarching pattern highlights the heightened incidence of cervical spinal stenosis in the older age group. Age-associated degenerative alterations, including intervertebral disc bulge, ligamentum flavum hypertrophy, osteophyte development, and facet joint arthropathy, progressively constrict the spinal canal and neural foramina, increasing the vulnerability of older adults to spinal canal stenosis and neural foraminal stenosis. Consequently, aging continues to be a significant risk factor in development and clinical presentation of cervical spinal stenosis.

Among the forty participants in the current study, 47.5% were male and 52.5% were female, indicating a slight female preponderance. Supplementary studies utilizing MRI have evaluated cervical SCS and NFS, and this gender distribution aligns with prior findings. Kini et al. observed a 52% male predominance, but Waheed H et al. reported a 54% female prevalence.[4,40] In contrast, PO I et al. reported a female representation of 30.8% and a higher male prevalence of 69.2%.[37] In their study population, Ko S et al. documented 243 men (55.5%) and 195 women (44.5%).[20] Fahmy et al. identified a distinctly female-dominant sample, including 25.6% men and 74.4% women.[40] Marc Hohenhaus et al. observed a very equitable distribution, comprising 46.5% women and 53.5% men.[38] These discrepancies in studies may reflect population demographics, health-seeking behaviors, and referral patterns. However, the presence of specific individuals and a relatively higher proportion of women in this study may indicate a potential gender-based discrepancy in the manifestation or interpretation of cervical spine symptoms, thus necessitating more investigation.

Examining disc level involvement in the present study, most patients showed single-level cervical disc degeneration (37.5%), followed by three-level involvement in 25%, two disc levels in 20%, four levels in 12.5%, and five levels in 5%. This pattern shows the slow features of cervical spondylotic changes, whereby multilevel involvement progressively occurs with age and the degenerative changes progress and also multilevel involvement was more in lower cervical disc levels. The literature has produced similar tendencies. Two to three level involvements were the most common seen by Ko S et al., suggesting that cumulative biomechanical stress in the mid-to lower cervical spine predisposing these segments to premature degeneration. Particularly in the C4–C7 levels, which are known for their significant load-bearing and mobility needs.[20] Marc Hohenhaus and colleagues observed a frequency of multilevel degenerative changes.[38] It is clinically relevant as it might affect surgical planning, especially in the decision between anterior or posterior decompression procedures, as multilevel cervical spinal stenosis may show more diffuse or complicated symptoms. The findings of this study support the present understanding that although single-level disease is common, multilevel involvement is also rather common and should be carefully considered during imaging and treatment planning.

The present study evaluated cervical spinal canal stenosis utilizing the Kang grading system spanning cervical segments C2 to C7. The C2–C3 level was the most commonly maintained area, with 87.5% of patients demonstrating Grade 0 stenosis, signifying no canal constriction. A gradual escalation in canal stenosis severity was noted at lower levels. At the C3–C4 level, Grade I, Grade II and Grade III stenosis were noted in 20%, 7.5% and 2.5% of individuals, respectively.

Significant spinal canal stenotic alterations were observed at the C4–C5, C5–C6 and C6-7 levels, with a notable rise in Grade II and Grade III cases. The most pronounced canal narrowing (Grade III) was primarily observed at C5–C6 (17.5%) and C6–C7 (10%) levels, compared to upper levels, suggesting that the lower cervical spine is more vulnerable to significant degenerative alterations.

These observations correspond with findings documented in prior literature. Kini et al. observed that the most severe stenosis grades were predominantly located at the C5–C6 intervertebral level.[39] Waheed H et al. and Po I et al. also identified a prevalence of stenotic alterations at C5–C6.[4] In Po I's study, the most pronounced stenosis (Grade III) was observed at the C3–C4 level, closely succeeded by C5–C6, indicating variety in segmental susceptibility among trials.[37] These findings underscore the clinical importance of assessing level-specific involvement, especially in the mid-to-lower cervical spine, which frequently endures the most substantial degenerative burden in symptomatic patients.

The current study evaluated the degree of neural foraminal stenosis at cervical levels C2 to C7 utilizing the Park grading system. At the C2–C3 level, the overwhelming majority of subjects (95%) exhibited no signs of foraminal stenosis (Grade 0), designating it as the least compromised segment. A mere 5% demonstrated moderate stenosis (Grade I). At the C3–C4 level, 62% of participants maintained Grade 0 neural foramina narrowing.

A significant escalation in severity was noted at the C4–C5 level, with merely 40% exhibiting no stenosis. The remaining 60% exhibited varied levels of constriction: 22.5% with Grade I, 10% with Grade II, and 5% with Grade III stenosis. Majority of the cases exhibited changes at C5–C6 level, 35%, 25% and 22.5% under grade I, II and III respectively. The C6–C7 level was identified as the second frequently and seriously impacted after C5-6 level, with merely 25% exhibiting no stenosis, while the distribution across other grades was as follows: Grade I (32.5%), Grade II (25%), and Grade III (17.5 %). This pattern indicates a gradual escalation of foraminal stenosis in the lower cervical spine and changes corresponding to spinal canal stenosis.

These results align with prior literature. Kim et al. indicated that although Grade 0 (no stenosis) was the most commonly encountered classification overall, the C6–C7 segment had the highest incidence of stenosis.[8] Park et al. also noted that severe foraminal constriction (Grades II and III) was rare at the C4–C5 level, whereas the C5–C6 level had a greater prevalence of Grade III stenosis relative to other areas.[25] These similarities highlight a prevalent trend in degenerative cervical pathology, where the lower cervical segments, especially C5-6 & C6–C7, exhibit increased susceptibility to substantial neural foraminal constriction as a result of age-related disc degeneration and mechanical stress.

In the current study, the Kang grading system—which stratifies the severity of cervical spinal canal stenosis based on MRI characteristics—exhibited a robust negative correlation with the JOA score ($r = -0.949$, $p < 0.001$). This strong inverse relationship indicates that patients with more advanced stenotic changes (higher Kang grades) experienced more severe neurological deficits, as reflected by lower JOA scores.

A strong positive correlation ($r = 0.879$, $p < 0.001$) was observed between the Park grading system for neural foraminal stenosis and the Neck Disability Index (NDI) score, indicating that higher grades of foraminal narrowing are closely associated with greater patient-reported NDI scores. This statistically significant association underscores the clinical relevance of radiological severity in predicting functional impairment. The Park grading system, therefore, not only serves as a structural assessment tool but also has potential prognostic value in guiding management strategies.

By aligning objective imaging findings with subjective disability measures, clinicians can adopt a more comprehensive, patient-centered approach to evaluating and treating cervical spine disorders.

These findings are consistent with those reported by Liu Q et al., who identified a statistically significant association between Kang grading and JOA scores in patients with cervical spondylotic myelopathy.[41] Their study demonstrated that as the grade of stenosis increased, functional scores decreased, further supporting the validity of the Kang system as a tool for clinical assessment.

Similarly, Maier IL et al. found that patients diagnosed with cervical spinal canal stenosis had significantly lower JOA scores compared to control subjects. The median JOA score for the stenosis group was 15 (IQR: 13.75–16.13), whereas the control group had a median score of 17 (IQR: 17–17), with a statistically significant difference ($p = 0.002$)[42]. This reinforces the impact of radiologically confirmed spinal canal compromise on neurological function and aligns with the current study's results, highlighting the prognostic value of Kang grading in clinical decision-making and outcome prediction.

STRENGTHS

This study possesses several significant strengths. Initially, it ensured consistency, repeatability, and objectivity in the radiological assessment by employing known and standardized MRI grading systems—Kang et al. for cervical canal stenosis and Park et al. for cervical foraminal stenosis. The study adeptly integrated imaging findings with established clinical scoring tools, specifically the NDI and the JOA Score, thereby facilitating a comprehensive evaluation of structural alterations in relation to functional and neurological deficits. The patient group comprises symptomatic individuals undergoing MRI assessment in a real-world clinical setting, hence enhancing the clinical relevance and applicability of the findings. The study demonstrated substantial correlations between MRI grading and clinical disability scores, so reinforcing the diagnostic and prognostic use of MRI in evaluating cervical spine disease.

LIMITATIONS

The study has constraints even if it has advantages. With just 40 participants in the sample, perhaps limiting the generalizability of the results to the wider population, The study was carried out at a single centre, resulting in centre-specific prejudices that can affect the external validity of the results that could be involved. By using a convenience sample approach instead of random sampling, one may have introduced selection bias and hence possibly compromised the representativeness of the study population. Moreover, the cross-sectional design of the trial excluded follow-up, therefore limiting knowledge of the evolution of illness or the consequences of treatments throughout time. The lack of interobserver variability assessment is another drawback since MRI grading was done by a single radiologist, thereby limiting understanding of the dependability of the grading system among several observers.

RECOMMENDATIONS

Given the results and constraints of the study, several suggestions might be made. Later studies should concentrate on involving more of a sample size and involving more centres to increase the generalizability and external validity of the conclusions. For assessing the relationships between MRI findings, disease development, treatment outcomes, and recovery, longitudinal studies including subsequent examinations would be quite helpful. Interobserver agreement in MRI grading should be assessed in future studies to ensure consistency and dependability of these grading systems among different radiologists. Combining additional diagnostic tools, such as dynamic MRI or electrophysiological evaluations, can help one better understand cervical spine pathology and its clinical consequences. Finally, improving understanding and training among radiologists and doctors in the implementation of uniform grading systems should help to promote consistency in diagnosis, reporting, and management decisions.

CONCLUSION

CONCLUSION

The present study highlights the significant role of MRI-based grading systems—namely the Kang grading system for cervical spinal canal stenosis and the Park grading system for neural foraminal stenosis—in assessing the severity of cervical degenerative changes and their correlation with clinical disability.

A progressive increase in stenosis severity was observed in the lower cervical levels, particularly at C5–C6 and C6–C7, indicating these segments are most vulnerable to degenerative pathology. Strong correlations were established between radiological grading and clinical outcomes, as evidenced by:

- A strong negative correlation between Kang grades and JOA scores, signifying that higher degrees of canal stenosis are associated with worse neurological function.
- A strong positive correlation between Park grades and NDI scores, demonstrating that increasing foraminal narrowing corresponds to greater neck-related disability.

These findings reinforce the diagnostic and prognostic value of standardized MRI grading systems in evaluating cervical spondylotic pathology. Incorporating such imaging-based assessments into routine clinical practice can enhance early diagnosis, severity stratification, and informed decision-making in managing symptomatic cervical spine disorders.

SUMMARY

SUMMARY

Age and Gender Distribution

Most participants were aged **51–60 years (32.5%)**, with a **mean age of 50.2 ± 12.96 years**. The cohort included **52.5% females** and **47.5% males**.

Disc Involvement

Single-level disc involvement was most common (37.5%), followed by three levels (25%) and two levels (20%).

Spinal Canal Stenosis (Kang Grading)

Stenosis increased toward the lower cervical spine. **C2–C3** showed minimal stenosis (87.5% Grade 0), while **C5–C6 (17.5%)** and **C6–C7 (10%)** had the highest Grade III involvement.

Neural Foraminal Stenosis (Park Grading)

C2–C3 had the least narrowing (95% Grade 0), whereas C5-6 and **C6–C7** showed the highest severity (Grade III) 22.5% and 17.5 % respectively.

Correlation Analyses

- **Kang grading vs. JOA**: Strong **negative correlation** ($r = –0.949$, $p < 0.001$).
- **Park grading vs. NDI**: Strong **positive correlation** ($r = 0.879$, $p < 0.001$)

.

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ANNEXURE

PROFORMA

“ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS”

DEMOGRAPHIC DETAILS

1. Name:
2. Age:
3. Gender:
4. UHID No:
5. Occupation:
6. Address:

CLINICAL HISTORY:

PERSONAL HISTORY:

FAMILY HISTORY:

CLINICAL EVALUATION:

JOA score:

NDI score:

RADIOLOGICAL EVALUATION:

KANG Grading (SCS):

PARK Grading (NFS):

INFORMED CONSENT

Study title: **"ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS "**

PG guide's name: Dr. HARINI BOPAIAH

Principal investigator: Dr. T. NISHANTH VARMA

Name of the subject:

Age:

Gender:

a. I have been informed in my own language that this study involves MRI C-spine as a part of the procedure. I have been explained thoroughly and understand the procedure.

b. I understand that the medical information produced by this study will become part of institutional record and will be kept confidential by the said institute.

c. I understand that my participation is voluntary and I may refuse to participate or may withdraw my consent and discontinue participation at any time without prejudice to my present or future care at this institution.

d. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

e. I confirm that Dr. HARINI BOPAIAH/ Dr. T. NISHANTH VARMA has explained to me the purpose of research and the study procedure that I will undergo and the possible discomforts that I may experience, in my own language. I hereby agree to give valid consent to participate as a subject in this research project

Participant's signature/ Thumb impression: Date:

Signature of the witness:

1)

2)

I have explained to ___________________________ (subject) the purpose of the research, the possible risk and benefits to the best of my ability.

Chief Researcher/ Guide signature

<u>ಮಾಹಿತಿಯುಕ್ತ ಒಪ್ಪಿಗೆ</u>

ಅಧ್ಯಯನದ ಶೀರ್ಷಿಕೆ: "ಲಕ್ಷಣ ರೋಗಿಗಳಲ್ಲಿ ಗರ್ಭಕಂಠದ ಬೆನ್ನುಮೂಳೆಯ ಕಾಲುವೆ ಸ್ಟೆನೋಸಿಸ್ ಮತ್ತು ಗರ್ಭಕಂಠದ ನರ ಫೋರಮಿನಲ್ ಸ್ಟೆನೋಸಿಸ್ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಎಂಆರ್ಐ ಪಾತ್ರ"

PG ಮಾರ್ಗದರ್ಶಿಯ ಹೆಸರು: ಡಾ. ಹರಿಣಿ ಬೋಪಯ್ಯ

ಪ್ರಧಾನ ತನಿಖಾಧಿಕಾರಿ: ಡಾ. ಟಿ. ನಿಶಾಂತ್ ವರ್ಮಾ

ವಿಷಯದ ಹೆಸರು:

ವಯಸ್ಸು:

ಲಿಂಗ:

a. ಈ ಅಧ್ಯಯನವು ಎಂಆರ್ಐ ಸಿ-ಬೆನ್ನುಮೂಳೆಯನ್ನು ಕಾರ್ಯವಿಧಾನದ ಭಾಗವಾಗಿ ಒಳಗೊಂಡಿದೆ ಎಂದು ನನಗೆ ನನ್ನದೇ ಭಾಷೆಯಲ್ಲಿ ತಿಳಿಸಲಾಗಿದೆ. ನನಗೆ ಸಂಪೂರ್ಣವಾಗಿ ವಿವರಿಸಲಾಗಿದೆ ಮತ್ತು ಕಾರ್ಯವಿಧಾನವನ್ನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

b. ಈ ಅಧ್ಯಯನದಿಂದ ಉತ್ಪತ್ತಿಯಾಗುವ ವೈದ್ಯಕೀಯ ಮಾಹಿತಿಯು ಸಾಂಸ್ಥಿಕ ದಾಖಲೆಯ ಭಾಗವಾಗುತ್ತದೆ ಮತ್ತು ಹೇಳಲಾದ ಸಂಸ್ಥೆಯು ಅದನ್ನು ಗೌಪ್ಯವಾಗಿಡುತ್ತದೆ ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

c. ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆ ಸ್ವಯಂಪ್ರೇರಿತವಾಗಿದೆ ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ ಮತ್ತು ಈ ಸಂಸ್ಥೆಯಲ್ಲಿ ನನ್ನ ಪ್ರಸ್ತುತ ಅಥವಾ ಭವಿಷ್ಯದ ಆರೈಕೆಗೆ ಯಾವುದೇ ಹಾನಿಯಾಗದಂತೆ ನಾನು ಭಾಗವಹಿಸಲು ನಿರಾಕರಿಸಬಹುದು ಅಥವಾ ನನ್ನ ಒಪ್ಪಿಗೆಯನ್ನು ಹಿಂತೆಗೆದುಕೊಳ್ಳಬಹುದು ಮತ್ತು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ನಿಲ್ಲಿಸಬಹುದು.

d. ಈ ಅಧ್ಯಯನದಿಂದ ಬರುವ ಯಾವುದೇ ಡೇಟಾ ಅಥವಾ ಫಲಿತಾಂಶಗಳ ಬಳಕೆಯನ್ನು ನಿರ್ಬಂಧಿಸುವುದಿಲ್ಲ ಎಂದು ನಾನು ಒಪ್ಪುತ್ತೇನೆ, ಆದರೆ ಅಂತಹ ಬಳಕೆಯು ವೈಜ್ಞಾನಿಕ ಉದ್ದೇಶ(ಗಳು) ಗಾಗಿ ಮಾತ್ರ.

ಇ. ಡಾ. ಹರಿಣಿ ಬೋಪಯ್ಯ/ ಡಾ. ಟಿ. ನಿಶಾಂತ್ ವರ್ಮಾ ಅವರು ಸಂಶೋಧನೆಯ ಉದ್ದೇಶ ಮತ್ತು ನಾನು ಒಳಗಾಗುವ ಅಧ್ಯಯನ ವಿಧಾನ ಮತ್ತು ನಾನು ಅನುಭವಿಸಬಹುದಾದ ಸಂಭಾವ್ಯ ಅನಾನುಕೂಲತೆಗಳನ್ನು ನನ್ನ ಸ್ವಂತ ಭಾಷೆಯಲ್ಲಿ ವಿವರಿಸಿದ್ದಾರೆ ಎಂದು ನಾನು ದೃಢೀಕರಿಸುತ್ತೇನೆ. ಈ ಸಂಶೋಧನಾ ಯೋಜನೆಯಲ್ಲಿ ವಿಷಯವಾಗಿ ಭಾಗವಹಿಸಲು ಮಾನ್ಯ ಒಪ್ಪಿಗೆಯನ್ನು ನೀಡಲು ನಾನು ಈ ಮೂಲಕ ಒಪ್ಪುತ್ತೇನೆ.

ಭಾಗವಹಿಸುವವರ ಸಹಿ/ ಹೆಬ್ಬೆರಳಿನ ಗುರುತು: ದಿನಾಂಕ:

ಸಾಕ್ಷಿಯ ಸಹಿ:

1)

2)

ಸಂಶೋಧನೆಯ ಉದ್ದೇಶ, ಸಂಭವನೀಯ ಅಪಾಯ ಮತ್ತು ಪ್ರಯೋಜನಗಳನ್ನು ನಾನು ______________________ (ವಿಷಯ) ಗೆ ನನ್ನ ಸಾಮರ್ಥ್ಯಕ್ಕೆ ತಕ್ಕಂತೆ ವಿವರಿಸಿದ್ದೇನೆ.

ಮುಖ್ಯ ಸಂಶೋಧಕ/ಮಾರ್ಗದರ್ಶಿ ಸಹಿ

PATIENT INFORMATION SHEET

“ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS”

Principal Investigator: Dr. T. NISHANTH VARMA/ Dr. HARINI BOPAIAH

I, Dr. T. NISHANTH VARMA, post-graduate student in Department of Radio-Diagnosis at Sri Devaraj Urs Medical College, will be conducting a study titled “ROLE OF MRI IN EVALUATION OF CERVICAL SPINAL CANAL STENOSIS AND CERVICAL NEURAL FORAMINAL STENOSIS IN SYMPTOMATIC PATIENTS, for my dissertation under the guidance of Dr. Harini Bopaiah, Professor, Department of Radiodiagnosis. In this study, we will assess the role of MRI in evaluation of cervical spinal canal stenosis and cervical neural foraminal stenosis. You will not be paid any financial compensation for participating in this research project. All of your personal data will be kept confidential and will be used only for research purpose by this institution. You are free to participate in the study. You can also withdraw from the study at any point of time without giving any reasons whatsoever. Your refusal to participate will not prejudice you to any present or future care at this institution.

Dr. T. NISHANTH VARMA

Name and signature of the Principal Investigator

Date

<u>ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆ</u>

"ಲಕ್ಷಣ ರೋಗಿಗಳಲ್ಲಿ ಗರ್ಭಕಂಠದ ಬೆನ್ನುಮೂಳೆಯ ಕಾಲುವೆಯ ಸ್ಟೆನೋಸಿಸ್ ಮತ್ತು ಗರ್ಭಕಂಠದ ನರಗಳ ಫೋರಮಿನಲ್ ಸ್ಟೆನೋಸಿಸ್ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಎಂಆರ್ಐ ಪಾತ್ರ"

ಪ್ರಧಾನ ತನಿಖಾಧಿಕಾರಿ: ಡಾ. ಟಿ. ನಿಶಾಂತ್ ವರ್ಮಾ/ ಡಾ. ಹರಿಣಿ ಬೋಪಯ್ಯ

ಶ್ರೀ ದೇವರಾಜ್ ಉರ್ಸ್ ವೈದ್ಯಕೀಯ ಕಾಲೇಜಿನಲ್ಲಿ ರೇಡಿಯೋ-ಡಯಾಗ್ನೋಸಿಸ್ ವಿಭಾಗದಲ್ಲಿ ಸ್ನಾತಕೋತ್ತರ ವಿದ್ಯಾರ್ಥಿಯಾಗಿರುವ ಡಾ. ಟಿ. ನಿಶಾಂತ್ ವರ್ಮಾ, ರೇಡಿಯೋಡಯಾಗ್ನೋಸಿಸ್ ವಿಭಾಗದ ಪ್ರಾಧ್ಯಾಪಕಿ ಡಾ. ಹರಿಣಿ ಬೋಪಯ್ಯ ಅವರ ಮಾರ್ಗದರ್ಶನದಲ್ಲಿ, ನನ್ನ ಪ್ರಬಂಧಕ್ಕಾಗಿ, "ಲಕ್ಷಣ ರೋಗಿಗಳಲ್ಲಿ ಗರ್ಭಕಂಠದ ಬೆನ್ನುಮೂಳೆಯ ಕಾಲುವೆಯ ಸ್ಟೆನೋಸಿಸ್ ಮತ್ತು ಗರ್ಭಕಂಠದ ನರಗಳ ಫೋರಮಿನಲ್ ಸ್ಟೆನೋಸಿಸ್ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಎಂಆರ್ಐ ಪಾತ್ರ" ಎಂಬ ಶೀರ್ಷಿಕೆಯ ಅಧ್ಯಯನವನ್ನು ನಡೆಸಲಿದ್ದೇವೆ. ಈ ಅಧ್ಯಯನದಲ್ಲಿ, ಗರ್ಭಕಂಠದ ಬೆನ್ನುಮೂಳೆಯ ಕಾಲುವೆಯ ಸ್ಟೆನೋಸಿಸ್ ಮತ್ತು ಗರ್ಭಕಂಠದ ನರಗಳ ಫೋರಮಿನಲ್ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಎಂಆರ್ಐ ಪಾತ್ರವನ್ನು ನಾವು ನಿರ್ಣಯಿಸುತ್ತೇವೆ. ಸ್ಟೆನೋಸಿಸ್. ಈ ಸಂಶೋಧನಾ ಯೋಜನೆಯಲ್ಲಿ ಭಾಗವಹಿಸಿದ್ದಕ್ಕಾಗಿ ನಿಮಗೆ ಯಾವುದೇ ಹಣಕಾಸಿನ ಪರಿಹಾರವನ್ನು ನೀಡಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಎಲ್ಲಾ ವೈಯಕ್ತಿಕ ಡೇಟಾವನ್ನು ಗೌಪ್ಯವಾಗಿಡಲಾಗುತ್ತದೆ ಮತ್ತು ಈ ಸಂಸ್ಥೆಯು ಸಂಶೋಧನಾ ಉದ್ದೇಶಕ್ಕಾಗಿ ಮಾತ್ರ ಬಳಸುತ್ತದೆ. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ಸ್ವತಂತ್ರರು. ಯಾವುದೇ ಕಾರಣಗಳನ್ನು ನೀಡದೆ ನೀವು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಅಧ್ಯಯನದಿಂದ ಹಿಂದೆ ಸರಿಯಬಹುದು. ಭಾಗವಹಿಸಲು ನಿಮ್ಮ ನಿರಾಕರಣೆಯು ಈ ಸಂಸ್ಥೆಯಲ್ಲಿನ ಯಾವುದೇ ಪ್ರಸ್ತುತ ಅಥವಾ ಭವಿಷ್ಯದ ಆರೈಕೆಗೆ ನಿಮ್ಮನ್ನು ಹಾನಿಗೊಳಿಸುವುದಿಲ್ಲ.

ಡಾ. ಟಿ. ನಿಶಾಂತ್ ವರ್ಮಾ

ಪ್ರಧಾನ ತನಿಖಾಧಿಕಾರಿಯ ಹೆಸರು ಮತ್ತು ಸಹಿ

ದಿನಾಂಕ

MASTER CHART

MASTER CHART

	Age	Gender	No-of discs involved	KANG GRADING SYSTEM					GRADES	JOA	PARK GRADING SYSTEM						NDI
				C2-C3	C3-C4	C4-C5	C5-C6	C6-C7			C2-C3	C3-C4	C4-C5	C5-C6	C6-C7	GRADES	
616578	45	F	1	0	0	0	1	0	1	14	0	0	3	0	1	3	25
538995	38	F	2	0	0	1	0	1	1	14	0	1	1	1	1	1	11
616859	64	F	1	0	0	0	0	3	3	8	0	0	0	1	0	3	27
618601	56	M	3	0	0	1	1	1	1	14	0	3	3	1	2	3	26
624794	43	F	1	0	0	0	0	2	2	10	0	0	0	2	2	2	21
620622	50	F	3	0	0	2	2	1	2	12	1	1	0	3	3	3	25
547292	62	M	4	1	0	1	3	2	3	7	0	1	2	3	2	3	32
620672	55	F	1	0	0	1	0	1	1	15	0	0	0	3	3	3	34
619111	41	M	3	0	1	1	0	2	2	11	0	1	1	1	2	2	22
622764	46	F	2	0	0	2	0	1	2	10	0	0	2	3	2	3	27
616186	60	M	1	0	0	0	0	3	3	8	0	1	1	1	0	1	5
621921	61	F	4	0	1	1	1	1	1	14	0	1	2	3	2	3	28
543210	65	F	4	2	1	2	3	0	3	8	0	2	2	1	2	2	16
543892	57	M	1	0	0	0	0	3	3	9	0	0	0	3	3	3	29
563182	36	F	1	0	0	0	2	0	2	13	0	0	3	3	1	3	29
523456	50	F	2	0	0	0	2	0	2	12	0	3	2	3	0	3	27
521348	60	F	4	0	0	1	1	1	1	14	0	2	1	2	1	2	18
514869	59	M	1	0	0	0	2	0	2	12	0	2	0	2	0	2	18
563194	60	M	3	0	1	1	1	0	1	14	0	1	1	1	0	1	14
531824	46	F	2	0	0	0	2	2	2	11	0	0	1	3	1	3	29
523140	55	F	3	0	1	2	2	0	2	12	0	1	1	1	1	1	7
586143	54	M	2	0	0	0	3	3	3	6	0	2	0	0	1	3	32
567182	49	F	1	0	0	0	2	0	2	11	0	0	3	0	0	3	25
561430	22	M	4	0	2	2	1	2	2	11	0	3	1	0	3	3	36
531821	33	M	3	0	0	3	1	2	3	6	0	3	1	0	2	3	34
541320	29	F	1	0	0	0	3	0	3	5	0	0	0	2	2	2	19
541832	78	M	5	1	2	3	1	1	3	8	1	0	2	2	1	2	18
531326	41	M	2	0	0	0	3	1	3	8	0	0	0	1	1	1	10
531727	24	M	1	0	0	2	0	2	2	12	0	0	0	2	2	2	20
536864	39	F	3	0	0	0	1	1	1	15	0	0	2	2	0	2	18
541230	25	M	2	0	0	2	3	0	3	7	0	0	0	1	1	3	37
612428	52	F	1	0	0	0	1	0	1	14	0	0	0	1	0	3	38
612363	66	M	3	0	1	2	1	0	2	11	0	0	0	2	1	2	19
613208	67	M	1	0	3	0	0	0	3	6	0	0	1	1	0	1	6
513865	50	M	2	0	0	0	3	2	3	5	0	0	0	0	1	3	32
501369	63	F	3	1	0	0	1	0	1	15	0	0	0	2	1	2	21
503987	60	M	1	0	0	0	0	0	1	15	0	0	1	0	3	3	45
531876	56	F	3	0	1	1	2	2	2	12	0	0	2	2	0	2	22
531950	53	F	5	1	1	1	1	1	1	14	0	0	0	1	3	3	43
521467	38	M	1	0	2	0	0	1	2	11	0	0	1	1	3	3	42