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# Accuracy study to evaluate the reliability of the new MRI grading system in cervical neural foraminal stenosis along with its distribution in various parameters /factors

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**Abstract**

**Background:** Narrowing of the cervical neural foramen which can be caused by degenerative changes such as osteophytes, hypertrophic facets or lateral disc herniation is defined as cervical neural foraminal stenosis (NFS). Since the anatomical changes mentioned above cause the cervical neural foramen to narrow, they can result in nerve root invasion, inflammation or both changes and result in cervical radiculopathy symptoms such as tingling, neck pain, etc. **Aim & Objective:** 1.To study the Diagnostic accuracy of the new Magnetic Resonance Imaging grading system for cervical neural foramina stenosis based on T2 weighted axial MRI images.2.To give recommendations based on the study **Methods: Study design:** A Cross Sectional Study. **Study setting:** Radiology department of tertiary care centre. Study duration: from…to….. **Study population:** The study population included all the cases with Suspected & Diagnosed cervical neural foraminal stenosis patients admitted at a tertiary care center **Sample size:** 126 **Results:** majority of the patients in male and female were from the age group of 41-50 years (22 males & 19 females). In the age group of 51-60 years, out of total 26 patients 14 (53.85%) were male and 12 (46.15%) were female. From above table, we can say that male to female distribution in all the age group was same. In all age groups male preponderance was observed but the difference was statistically not significant ($p>0.05$). Pain was the most common presenting symptom observed in 123 (97.62%) Most commonly observed stenosis was Grade 0 (48.88%). Severity of stenosis (grade 2) was more at the level C6-C7 (30.16% on right and 36.5% on left side) than at level C5-C6 (25.29% on right side and 26.79% on left side) and at level C4-C5 (13.49% on right side and 12.69% on left side). intra observer reliability according to grading of cervical neural foramina stenosis. Intra observer agreement ranged from 85.3 to 93.6. Maximum agreement was seen at level C4-C5 on right side and lowest agreement was observed at level C4-C5 on left side. Overall agreement for grading of cervical neural foramina stenosis was 89.5. Overall agreement for presence of stenosis was 80.5. It indicates moderate agreement. Maximum agreement (87.6) was observed at level C4-C5 on left side and lowest (78.1) was seen at level C6-C7 on right side. **Conclusions:** The new MRI grading system shows sufficient interobserver and intraobserver agreement to reliably assess cervical neural foraminal stenosis. This new grading system is a useful and easy method for the objective evaluation ofcervical neural foraminal stenosis by radiologists and clinicians.

**Keywords:** MRI, foraminal stenosis, intraobserver reliability, Inter observer reliability

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## Introduction

Cervical radiculopathy resulting from neural foraminal stenosis is an important disease due to its long-term effects. Spinal cord compression is a major cause of radiculopathy. Compression of the cervical cord is observed in 10% of cases of spinal cord compression. The prevalence of cervical cord compression is approximately 24.4% [1]

Narrowing of the cervical neural foramen which can be caused by degenerative changes such as osteophytes, hypertrophic facets or lateral disc herniation is defined as cervical neural foraminal stenosis (NFS) [2-4]. Since the anatomical changes mentioned above cause the cervical neural foramen to narrow, they can result in nerve root invasion, inflammation or both changes and result in cervical radiculopathy symptoms such as tingling, neck pain, etc.

Diagnosis of cervical foramen stenosis can be made with history, clinical examination, and imaging techniques. Computed tomography and magnetic resonance imaging are used for diagnosis. The imaging modality of choice for the cervical spine is magnetic resonance imaging. Early diagnosis and treatment of cervical neural foramen stenosis prevents long-term disabilities due to irreversible spinal cord injury. [5]

MRI discriminates various soft tissues of the spinal cord and bone tissue. Conventional MRI shows axial and sagittal images of the cervical spine.[6] Recently, oblique images are being used to diagnose cervical foramen stenosis.[7]The anatomy of the cervical spine, including the bony portion, surrounding soft tissues, and spinal cord is well visualized on MRI, but assessment of cervical neural foraminal stenosis is challenging on MRI imaging due to its relatively small size and susceptibility to degeneration of the cervical vertebral column. [8-10] Many studies have been carried out to evaluate the stenosis of the cervical neural foramen.[11-17]

An objective grading system for the assessment of cervical neural foramen stenosis is needed to aid in the clinical investigation of cervical neural foramen stenosis and will also help generate consistent and accurate radiological reports. It will help identify the correlation between MRI findings and clinical symptoms caused by narrowing of the cervical neural foramina.

The classification of cervical neural foraminal stenosis is important because the patient's treatment depends on it. For grade 1 (non-severe) stricture, treatment is primarily with drugs. For grade 2 (severe) stricture, treatment is primarily surgical. Cervical neural foramen stenosis must be diagnosed accurately and studies have been conducted in the past, but in these studies the classification of the stenosis was subjective. Therefore, an objective classification system proposed by Sujin Kim et al in 2015 [18] was needed that would help to obtain consistent and accurate radiological reports. This system basically eliminates subjectivity and brings objectivity so that everyone reports uniformly. Due to the lack of information, this system is not widely practiced and no reliability studies of this system have been conducted or published in India.

## Aim And Objective

### Objective:

1. To study the Diagnostic accuracy of the new Magnetic Resonance Imaging grading system for cervical neural foramina stenosis based on T2 weighted axial MRI images.
2. To give recommendations based on the study

## Material And Methods

**Study design:** A Cross Sectional study

**Study setting:** Radiology department of tertiary care centre

**Study duration:** From…to….

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**Study population:** The study population included all the cases with acute myocardial infarction patients admitted at a tertiary care center

**Inclusion Criteria**

1. History of neck pain and tingling numbness sensation in cervical region.
2. Suspected & Diagnosed cervical neural foraminal stenosis pts.

**Exclusion Criteria**

1. Patients with metallic clips, implants
2. Patients who are claustrophobic.
3. Patients with history of trauma
4. Previous spinal operation
5. Histologically proven or suspected tumor

**Ethical Consideration:** The study was approved by the Ethical Committee of the Medical College.

**Consent:** A valid written Consent was taken from the patients after explaining the protocol to them in thelanguage that the patient best understood.

**Data collection:**

126 patients who fulfilled the inclusion criteria mentioned above were selected for the study. Data included demographic details like age, sex etc. Detailed clinical history was noted. Present complaints, any significant past history was noted. Through clinical examination notes were taken from the neurology department. All above details were recorded in case proforma. (Annexure l)

All patients underwent MRI. A MRI study was done in axial planes with T2. MR images were taken with Wipro GE Health Care 1.5 Tesla (Optima 360-16 channel) MRI machine. With the patient is supine position, MR images were acquired with a 1.5T scanner using a head and neck coil for the 1.5T imager. Axial T2-weighted images at the cervical disc level were acquired parallel to the disc spaces with the following parameters: number of axial sections in each disc =

4.repetition time 3131–4307 ms; echo time 80–120 ms; field of view = 150–150 mm; section thickness = 3 mm;

Cervical neural foramen narrowest width at C4/5,C5/6,C6/7 level on right and left side was measured. Width of cervical extraforaminal nerve root which was taken at the level of anterior margin of superior articular process.

(Two groups of radiologist interpreted the results. Each team had 4 radiologists, three in each group had 5-7 years experience and 1 was radiology resident with 2 years of experience.)

All the MR images were reported by the investigator. First reading was taken as soon as the MR image was taken. Second reading was taken by the same investigator 3 months after the first reading to avoid memory bias. All images were hidden for name, age and sex of the patient to avoid bias.

**Data entry and analysis**

The data were entered in Microsoft Excel and data analysis was done by using SPSS demo version no 21 for windows. The analysis was performed by using percentages in frequency tables and correlation of stroke. $p<0.05$ was considered as level of significance using the Chi-square test

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## Result And Observation

**Table 1: Distribution of patients according to age and sex**

| Sr no | Age group (years) | Male | Female | Total |
|---|---|---|---|---|
| 1 | 18-30 | 05(62.5%) | 03(37.5%) | 08 (100%) |
| 2 | 31-40 | 12(57.14%) | 09 (42.86%) | 21(100%) |
| 3 | 41-50 | 22(53.66%) | 19(46.34%) | 41(100%) |
| 4 | 51-60 | 14 (53.85%) | 12(46.15%) | 26(100%) |
| 5 | 61-70 | 12 (52.17%) | 11(47.83%) | 23(100%) |
| 6 | >70 | 04(57.14%) | 03(42.86%) | 07(100%) |
| **7** | **Total** | **69 (54.76%)** | **57(45.24%)** | **126(100%)** |

**P>0.05 NS- statistically not significant**

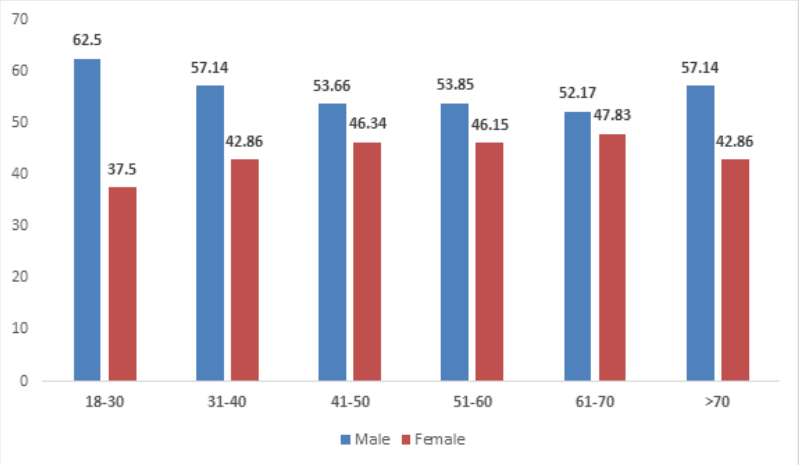


**Figure 1**

In our study, majority of the patients in male and female were from the age group of 41-50 years (22 males & 19 females). In the age group of 51-60 years, out of total 26 patients 14 (53.85%) were male and 12 (46.15%) were female. From above table, we can say that male to female distribution in all the age group was same. In all age groups male preponderance was observed but the difference was statistically not significant (p>0.05).

**Table 2: Distribution of patients according to symptoms**

| Sr no | Symptoms | No of patients | Percentage |
|---|---|---|---|
| 1 | Pain | 123 | 97.62 |
| 2 | Numbness | 71 | 56.35 |
| 3 | Tingling | 15 | 11.90 |
| 4 | Weakness | 06 | 4.76 |
| 5 | Gait Instability | 07 | 5.55 |

Table 2 shows distribution of the patients according to presenting symptoms. Pain was the most common presenting symptom observed in 123 (97.62%) patients. Second most common symptom was numbness observed in 71(56.35%) patients. Other presenting symptoms were Tingling (11.9%), weakness (4.76%) and Gait instability (5.55%).

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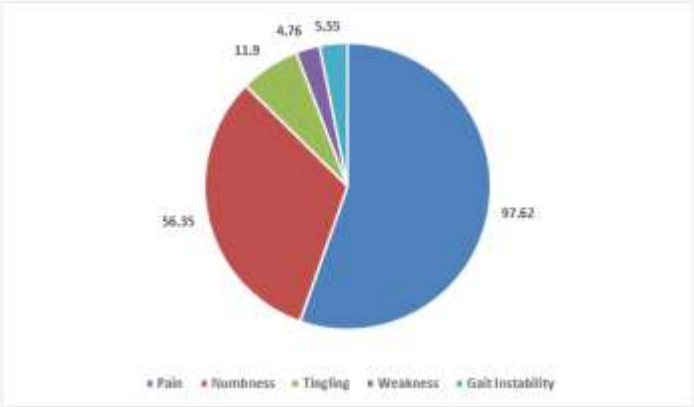


**Figure 2**

**Table 3: Intra observer reliability according to grading of CNFS**

| Level of CFS | Agreement | Kappa value | ICC |
|---|---|---|---|
| C4-C5 | | | |
| Right | 93.6 | 0.92 | 0.9 |
| Left | 85.3 | 0.80 | 0.81 |
| C5-C6 | | | |
| Right | 88.4 | 0.87 | 0.85 |
| Left | 89.2 | 0.87 | 0.91 |
| C6-C7 | | | |
| Right | 91.6 | 0.91 | 0.93 |
| Left | 88.4 | 0.87 | 0.9 |
| Overall | 89.5 | 0.87 | 0.91 |

**ICC- Intraclass correlation coefficient**

Table 3 shows intra observer reliability according to grading of cervical neural foramina stenosis. Intra observer agreement ranged from 85.3 to 93.6. Maximum agreement was seen at level C4- C5 on right side and lowest agreement was observed at level C4-C5 on left side. Overall agreement for grading of cervical neural foramina stenosis was 89.5.Weighted Kappa value for intraobserver reliability ranged from 0.8 to 0.92. Maximum kappa value was seen at level C4-C5 level on right side and lowest kappa was seen at level C4-C5 on left side. Overall kappa value was 0.87 which indicates excellent agreement. Intraclass correlation coefficient at all level ranged from 0.81 to 0.93. It indicates excellent agreement.

**Table 4: Intra observer reliability according to stenosis of CNFS (Grade 0 vs 1,2)**

| Level of CFS | Agreement | Kappa value |
|---|---|---|
| C4-C5 | | |
| Right | 96.8 | 0.94 |
| Left | 91.6 | 0.82 |
| C5-C6 | | |
| Right | 94.4 | 0.86 |
| Left | 96.8 | 0.93 |
| C6-C7 | | |
| Right | 97.6 | 0.95 |
| Left | 96.8 | 0.92 |
| Overall | 95.8 | 0.90 |

Table 4 shows Intra observer reliability according to stenosis of CNFS (Grade 0 vs grade

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1,2). Intraobserver agreement for the presence of stenosis was calculated as grade 0 vs grade 1 and 2. The agreement ranged from 91.6 to 97.6. Maximum agreement was observed at level C6-C7 on right side and lowest was seen at level C4-C5 on left side. Overall agreement for grading of cervical neural foramina stenosis was 95.8.

## Discussion

The study was conducted in MRI section of Department of Radio-Diagnosis in tertiary care hospital. 126 patients with complaints of neck pain and tingling numbness sensation in cervical region and Suspected & Diagnosed cervical neural foraminal stenosis were studied. Data was independently analysed by two groups of radiologists.

### Sociodemographic factors

In our study, out of total 126 patients 69(54.76%) were male and 57(45.24%) were females. Male to female ratio was 1.2:1.

In our study, majority of the patients in male and female were from the age group of 41-50 years (22 males & 19 females). In the age group of 51-60 years, out of total 26 patients 14 (53.85%) were male and 12 (46.15%) were female.

In a study by SangbongKo et al,[19] The incidences were studied in a community-based population of people who did not have any clinical symptoms of cervical neural foraminal stenosis. There were 195 females and 243 males among the 438 patients. The patients' average age was 54.3 years (range, 20 to 84 years); males' average age was 55.4 years (range, 21 to 82 years) and females' average age was 53 years (range, 20 to 84 years). Above findings are similar with our study.

### Clinical features

Pain was the most common presenting symptom observed in 123 (97.62%) patients. Second most common symptom was numbness observed in 71(56.35%) patients. Other presenting symptoms were Tingling (11.9%), weakness (4.76%) and Gait instability (5.55%).

### Intra observer agreement

intra observer reliability according to grading of cervical neural foramina stenosis. Intra observer agreement ranged from 85.3 to 93.6 Overall agreement for grading of cervical neural foramina stenosis was 89.5. Weighted Kappa value for intraobserver reliability ranged from 0.8 to 0.92. Overall kappa value was 0.87 which indicates excellent agreement. Intraclass correlation coefficient at all level ranged from 0.81 to 0.93. It indicates excellent agreement. In our study, Weighted Kappa value for intraobserver reliability for presence of stenosis ranged from 0.82 to 0.95. Overall kappa value for grading of cervical NFS was 0.90. It indicates excellent agreement.

Intra observer reliability according to severity of cervical NFS (Grade 0,1 vs 2). Weighted Kappa value for intraobserver reliability for severity of stenosis ranged from 0.80 to 0.90. overall Kappa value was 0.82. It indicates excellent agreement.

### Inter observer agreement

inter observer reliability according to grading of cervical neural foramina stenosis. Interobserver agreement for grading of cervical foramina stenosis ranged from 62.6 to 71.8. Overall agreement for grading of cervical neural foramina stenosis was 65.8. Weighted Kappa value for inter observer reliability ranged from 0.50 to 0.57. Overall kappa value was 0.51 which indicates moderate agreement. Intraclass correlation coefficient at all level ranged from 0.67 to 0.72. It indicates moderate agreement

## Conclusion

The present study concludes that the new MRI grading system is reliable for grading of cervical neural foraminal stenosis.The new MRI grading system shows sufficient interobserver and intraobserver agreement to reliably assess cervical neural foraminal stenosis.This new grading system is a useful and easy method for the objective

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evaluation ofcervical neural foraminal stenosis by radiologists and clinicians.

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