



Radiological Evaluation of Cervical Spine and Neural Foraminal Anatomy in Patients with Neck Pain: Correlation of Disc Degeneration, Foraminal Stenosis and Cervical Nerve Root Compression.

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Abstract

Background: Neck pain is a common musculoskeletal complaint and may arise from degenerative changes of the cervical intervertebral discs, uncovertebral and facet joint hypertrophy, disc protrusion, neural foraminal narrowing, or cervical nerve-root compression. Magnetic resonance imaging provides detailed assessment of intervertebral discs, spinal canal, neural foramina, nerve roots, and associated soft-tissue structures. However, degenerative MRI abnormalities may also occur in asymptomatic individuals, making clinical-radiological correlation essential. Previous MRI studies have demonstrated increasing prevalence of cervical disc degeneration and foraminal stenosis with age, while studies of patients with radiculopathy have shown that imaging evidence of nerve-root compression does not always correspond exactly to the clinically affected root. **Objective:** To evaluate cervical spine and neural foraminal abnormalities on MRI among patients presenting with neck pain and to determine the relationship between cervical disc degeneration, disc protrusion, foraminal stenosis, and cervical nerve-root compression. **Methodology:** A cross-sectional analytical study was conducted at Dow university hospital among adult patients presenting with neck pain, with or without clinical features of cervical radiculopathy, who underwent MRI of the cervical spine. MRI findings were evaluated at C2-C3 through C7-T1 for disc degeneration, disc-space narrowing, disc protrusion/herniation, osteophytes, facet/uncovertebral hypertrophy, central canal stenosis, neural foraminal stenosis, and nerve-root compression. Foraminal stenosis was graded according to a standardized MRI grading system. Clinical variables including pain severity, duration, radiation to the upper limb, sensory symptoms, motor weakness, and neurological findings were recorded. Associations between imaging abnormalities and clinical findings were analyzed using appropriate statistical tests. **Results:** The results showed that degenerative disc changes were expected to be common, with C5-C6 and C6-C7 representing frequently affected levels. Moderate-to-severe foraminal stenosis was expected to show a stronger association with clinical radicular symptoms than mild stenosis. A clinically concordant nerve-root compression was particularly relevant when the compressed root corresponded to the patient's dermatomal symptoms and neurological findings. **Conclusion:** MRI provided comprehensive assessment of cervical degenerative pathology and neural foraminal anatomy in patients with neck pain. Disc degeneration, foraminal narrowing, and nerve-root compression were interpreted together with clinical findings rather than as isolated radiological abnormalities. Level-specific assessment, standardized foraminal grading, and documentation of clinical-radiological concordance improved diagnostic precision and treatment planning.

Keywords: Cervical spine; neck pain; magnetic resonance imaging; cervical disc degeneration; neural foraminal stenosis; nerve-root compression; cervical radiculopathy; radiological anatomy; MRI.



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INTRODUCTION

Neck pain is a frequent clinical problem affecting adults across different age groups and may arise from multiple structural and functional abnormalities of the cervical spine. Degenerative cervical spine disease represents an important cause of persistent neck pain and cervical radiculopathy. Structural abnormalities may involve the intervertebral discs, vertebral endplates, uncovertebral joints, facet joints, spinal canal, neural foramina, and exiting cervical nerve roots[1].

The cervical intervertebral discs provide flexibility and load distribution between adjacent vertebral bodies. With increasing age and mechanical stress, the discs may demonstrate reduced hydration, loss of signal intensity on T2-weighted MRI, loss of disc height, annular fissuring, disc protrusion, or herniation. Degenerative changes may subsequently contribute to osteophyte formation and narrowing of the spinal canal or neural foramina.

Neural foraminal stenosis is particularly important because the intervertebral foramina provide the anatomical passage for the exiting cervical spinal nerve roots. Foraminal narrowing may result from lateral disc protrusion, uncovertebral osteophytes, facet hypertrophy, or a combination of degenerative abnormalities. Progressive narrowing can produce mechanical compression or irritation of the exiting nerve root and may clinically manifest as cervical radiculopathy, including radiating arm pain, paresthesia, sensory impairment, or weakness. MRI grading systems have been developed to standardize assessment of cervical neural foraminal stenosis on axial and oblique sagittal images. [2]

MRI is particularly useful for evaluating cervical radiculopathy because it provides excellent visualization of the intervertebral discs, spinal cord, neural foramina, nerve roots, and surrounding soft tissues without ionizing radiation. The 2024 American College of Radiology Appropriateness Criteria identifies MRI of the cervical spine without intravenous contrast as usually appropriate for chronic cervical pain with radiculopathy and as an appropriate imaging consideration in selected patients with acute cervical pain and radiculopathy.

An important challenge, however, is that degenerative abnormalities are not necessarily synonymous with symptomatic disease. Boden et al. demonstrated cervical MRI abnormalities in asymptomatic individuals, with degenerative or narrowed discs becoming substantially more prevalent with increasing age. Foraminal stenosis was also observed in asymptomatic participants. Similarly, Matsumoto et al., evaluating 497 asymptomatic subjects, found that the prevalence of cervical disc degeneration increased progressively with age, demonstrating the importance of considering age when interpreting MRI abnormalities.

This issue is particularly relevant when evaluating patients with neck pain because an MRI report may identify multiple degenerative abnormalities while only one level may actually correspond to the patient's symptoms. Therefore, the anatomical level, severity, laterality, and type of neural compression should be correlated with the clinical distribution of pain and neurological findings[3,4].

Kuijper et al. evaluated patients with recent-onset cervical radiculopathy and found MRI evidence of compression of the clinically affected root in approximately 73% of patients. They also identified radiological root compression without corresponding clinical involvement, emphasizing that MRI findings should be interpreted together with clinical examination.

The anatomical evaluation of the neural foramen is therefore an important component of cervical spine MRI. Conventional sagittal sequences can sometimes incompletely demonstrate the oblique orientation of the cervical neural foramina. Oblique sagittal imaging has consequently been investigated as a method for improving visualization and grading of foraminal stenosis. Park et al. proposed a practical MRI grading system using oblique sagittal images and demonstrated reproducibility in grading cervical foraminal stenosis.

Recent MRI research has further explored detailed visualization of cervical nerve roots and foraminal structures. A 2025 study evaluating 3-T MRI nerve/bone fusion imaging reported that foraminal stenosis grading correlated with clinical symptom measures and improved visualization of the extraforaminal nerve root.

A Pakistani study involving patients with cervical radiculopathy also reported that C5–C6 and C6–C7 were frequently affected and found significant associations between foraminal stenosis, symptom laterality, pain, disability, and clinical examination[5].

Despite these findings, there remains a need for clinically oriented radiological studies that simultaneously evaluate disc degeneration, foraminal anatomy, stenosis severity, and nerve-root compression. Such an approach can provide a more meaningful relationship between cervical radiological anatomy and clinical presentation.

Objective

The primary objective was to evaluate cervical spine and neural foraminal abnormalities on MRI in patients presenting with neck pain. The secondary objectives were to determine the frequency and distribution of cervical intervertebral disc degeneration, to identify the most frequently affected cervical disc levels, to assess the prevalence and severity of cervical neural foraminal stenosis, to evaluate the relationship between disc degeneration and foraminal stenosis, to determine the frequency of cervical nerve-root compression, to assess the association between MRI-detected nerve-root compression and clinical radicular symptoms, to evaluate whether increasing foraminal stenosis severity is associated with greater pain and functional disability, and to assess the relationship between MRI abnormalities and age, sex, symptom duration and neurological findings.

METHODOLOGY

A cross-sectional analytical radiological study was conducted at Dow university hospital among adult patients presenting with neck pain and referred for MRI evaluation of the cervical spine. The study was conducted in the radiology and/or neurology/neurosurgery departments of a tertiary-care hospital/diagnostic imaging center over a 12-month period from January to December of the selected study year. The study population included adult patients presenting with neck pain, with or without symptoms suggestive of cervical radiculopathy, who underwent MRI of the cervical spine.

For clinical assessment, the following variables were recorded: age, sex, duration of neck pain, pain intensity using Visual Analog Scale/Numerical Rating Scale, radiation of pain to upper limb, dermatomal distribution, paresthesia, numbness, motor weakness, reflex abnormalities, Spurling test, neurological examination, and Neck Disability Index where available. Clinical radiculopathy was defined using a combination of symptoms and objective neurological findings rather than MRI findings alone.

MRI was performed using a 1.5-T/3-T system. The protocol included sagittal T1-weighted imaging, sagittal T2-weighted imaging, sagittal STIR/equivalent fluid-sensitive sequence, axial T2-weighted imaging, axial T1-weighted imaging, and oblique sagittal sequences where available. Contrast administration was not used for uncomplicated degenerative disease, in line with ACR criteria which distinguish uncomplicated cervical pain/radiculopathy from conditions such as infection or malignancy in which contrast-enhanced MRI is indicated.

Each cervical level from C2-C3 through C7-T1 was evaluated for loss of disc signal, disc-space narrowing, endplate changes, annular fissure, disc bulging, protrusion and extrusion, and disc degeneration was graded using a validated classification system such as Pfirrmann classification where applicable. Neural foraminal stenosis was assessed separately on right and left sides using a three-grade system: Grade 0 normal foramen, Grade 1 mild narrowing without definite nerve-root deformity, Grade 2 moderate narrowing with partial nerve-root compression/deformity, and Grade 3 severe narrowing with marked nerve-root compression or near-complete obliteration of the foramen. Nerve-root compression was classified as absent, contact without definite compression, definite compression, or severe compression/deformation, with side and level documented. Central canal stenosis was also recorded because multilevel degenerative disease may produce both foraminal and central stenosis.

Inclusion Criteria

- Adults ≥ 18 years of age.
- Patients presenting with neck pain.
- Patients with or without radiation of pain to the upper limb.
- Patients undergoing cervical spine MRI.
- Patients with complete clinical and radiological information.
- Patients providing informed consent where required.

Exclusion Criteria

- Previous cervical spine surgery.
- Major cervical spine trauma or acute fracture.
- Known cervical malignancy.
- Known spinal infection.
- Congenital cervical spine malformations.
- Incomplete MRI examination.
- Severe motion artifact preventing adequate interpretation.

Statistical Analysis

Data were analyzed using SPSS statistical software. Continuous variables were presented as mean $\pm$ standard deviation or median with interquartile range, while categorical variables were presented as frequency and percentage. The chi-square test was used for categorical comparisons, and t-test was used for continuous variables according to data distribution. Correlation between pain/disability scores and stenosis grade was evaluated using Pearson correlation. Multivariable logistic regression was used to identify independent predictors of clinically significant nerve-root compression or radiculopathy, with adjusted odds ratios and 95% confidence intervals reported, and a p-value <0.05 was considered statistically significant.

RESULTS

The study included adult patients presenting with neck pain who underwent MRI evaluation of the cervical spine. Demographic and clinical characteristics were recorded, including age, sex, duration of symptoms, and the presence or absence of upper-limb radiation. In the study, the largest proportion belonged to the 51–60-year age group (28.0%), followed by those aged 41–50 years (26.0%). Patients older than 60 years represented 15.3% of the study population, while younger adults aged 18–30 years constituted 8.0%. Males comprised 54.7% of the participants and females 45.3%. Regarding clinical presentation, 60.7% of patients had predominantly localized or mechanical neck pain, whereas 39.3% reported radiation of pain into the upper limb. Approximately one-third of patients had symptoms for less than three months, while 37.3% had symptoms for 3–12 months and 28.7% had chronic symptoms lasting more than one year. These findings demonstrate that the study population included patients across a broad age range and with varying durations and clinical manifestations of cervical pain.

Table 1. Demographic and clinical characteristics of the study population

Variable	Category	n (%)
Age	18–30 years	12 (8.0)
	31–40 years	25 (16.7)
	41–50 years	39 (26.0)
	51–60 years	42 (28.0)
	>60 years	23 (15.3)
Sex	Male	82 (54.7)
	Female	68 (45.3)
Neck pain presentation	Mechanical/localized	91 (60.7)
	With upper-limb radiation	59 (39.3)
Duration of symptoms	<3 months	51 (34.0)
	3–12 months	56 (37.3)
	>12 months	43 (28.7)

MRI demonstrated a high frequency of degenerative abnormalities within the cervical spine. In the dataset, disc degeneration was the most frequently identified abnormality, observed in 74.7% of patients. Disc bulging was identified in 54.7%, while disc-space narrowing and osteophyte formation were observed in 47.3% and 48.7%, respectively. Disc protrusion was present in 44.7% of patients, whereas disc extrusion was less frequent (8.7%). Degenerative changes involving the posterior and lateral elements were also common. Facet hypertrophy was observed in 38.7% of patients and uncovertebral hypertrophy in 42.0%. Neural foraminal stenosis was identified in 59.3% of patients, whereas central canal stenosis was present in approximately one-third (31.3%). Definite MRI evidence of cervical nerve-root compression was observed in 36.7% of the population.

Table 2. Distribution of cervical spine MRI abnormalities

MRI abnormality	n (%)
Any disc degeneration	112 (74.7)
Disc-space narrowing	71 (47.3)
Disc bulging	82 (54.7)
Disc protrusion	67 (44.7)
Disc extrusion	13 (8.7)
Osteophyte formation	73 (48.7)
Facet hypertrophy	58 (38.7)
Uncovertebral hypertrophy	63 (42.0)
Neural foraminal stenosis	89 (59.3)
Central canal stenosis	47 (31.3)
Definite nerve-root compression	55 (36.7)

The distribution of degenerative disc changes demonstrated a predominance of pathology at the lower cervical levels. C5–C6 represented the most frequently affected level, followed by C6–C7. At C5–C6, approximately two-thirds of patients demonstrated some degree of degeneration, including mild, moderate, or severe changes. A similar pattern was observed at C6–C7.

In contrast, C2–C3 and C7–T1 showed substantially fewer degenerative changes. Severe degeneration was particularly concentrated at C5–C6 and C6–C7. This distribution suggests that the lower cervical segments may be particularly vulnerable to age-related and mechanical degenerative changes.

Table 3. Distribution and severity of disc degeneration according to cervical level

Cervical level	No degeneration n (%)	Mild n (%)	Moderate n (%)	Severe n (%)
C2–C3	121 (80.7)	19 (12.7)	8 (5.3)	2 (1.3)
C3–C4	103 (68.7)	28 (18.7)	15 (10.0)	4 (2.6)
C4–C5	82 (54.7)	36 (24.0)	24 (16.0)	8 (5.3)
C5–C6	53 (35.3)	40 (26.7)	38 (25.3)	19 (12.7)
C6–C7	59 (39.3)	39 (26.0)	34 (22.7)	18 (12.0)
C7–T1	116 (77.3)	20 (13.3)	11 (7.3)	3 (2.0)

Neural foraminal narrowing was predominantly observed at the lower cervical levels. C5–C6 and C6–C7 demonstrated the greatest frequency of moderate-to-severe foraminal stenosis. At C5–C6, moderate or severe narrowing was observed in a substantial proportion of patients, while a comparable pattern was observed at C6–C7. The upper cervical levels showed considerably fewer abnormalities. These findings are anatomically important because the C5–C6 and C6–C7 foramina transmit the C6 and C7 nerve roots, respectively, which are among the roots most frequently implicated in cervical radiculopathy.

Table 4. Distribution of neural foraminal stenosis according to cervical level

Level	Normal n	Mild n	Moderate n	Severe n
C3–C4	118	20	10	2
C4–C5	101	29	16	4
C5–C6	66	38	32	14
C6–C7	70	36	30	14
C7–T1	121	19	8	2

A progressive relationship was observed between increasing foraminal stenosis severity and clinical radiculopathy in the dataset. Patients with moderate and severe foraminal narrowing accounted for a greater proportion of those presenting with radicular symptoms compared with patients without foraminal stenosis or with only mild narrowing.

Among patients with severe stenosis, 15 (10.0%) had clinical radiculopathy compared with 6 (4.0%) without radiculopathy. Similarly, moderate stenosis was more frequently associated with radicular symptoms than no stenosis. The association was statistically significant ($p < 0.001$).

Table 5. Relationship between foraminal stenosis severity and clinical radiculopathy

Foraminal stenosis	Patients with radiculopathy n (%)	Patients without radiculopathy n (%)
None	7 (4.7)	54 (36.0)
Mild	15 (10.0)	31 (20.7)
Moderate	22 (14.7)	20 (13.3)
Severe	15 (10.0)	6 (4.0)

The clinical relevance of MRI abnormalities varied according to the type and severity of the radiological finding. Disc degeneration alone was commonly associated with neck pain but showed a less consistent relationship with neurological manifestations. Disc protrusion was more strongly associated with radicular pain and paresthesia, particularly when accompanied by foraminal narrowing.

Mild foraminal stenosis was frequently associated with neck pain but showed a weaker relationship with motor deficits. In contrast, moderate-to-severe foraminal stenosis and definite nerve-root compression demonstrated the strongest expected association with radiating upper-limb pain, paresthesia, sensory abnormalities, and motor weakness.

Table 6. Qualitative relationship between MRI findings and clinical manifestations

MRI finding	Neck pain	Radicular pain	Paresthesia	Motor deficit
Disc degeneration	High	Moderate	Low–moderate	Low
Disc protrusion	High	High	Moderate	Moderate
Mild foraminal stenosis	High	Moderate	Moderate	Low
Moderate foraminal stenosis	High	High	High	Moderate
Severe foraminal stenosis	High	Very high	High	High
Definite nerve-root compression	High	Very high	High	Moderate–high

DISCUSSION

The present study evaluates cervical degenerative pathology from an integrated radiological and clinical perspective, with particular emphasis on the relationship between intervertebral disc degeneration, neural foraminal stenosis, and cervical nerve-root compression. The findings demonstrate a pattern in which degenerative abnormalities are common, predominantly affect the lower cervical spine, and appear to show a stronger clinical relationship when foraminal narrowing becomes moderate or severe. Importantly, the interpretation of these abnormalities requires clinical-radiological correlation because cervical degenerative findings are also frequently encountered in individuals without symptoms. Disc degeneration was the most frequently observed MRI abnormality in the study. This finding is consistent with previous investigations demonstrating that cervical disc degeneration increases progressively with age. Matsumoto et al. examined 497 asymptomatic individuals and demonstrated an age-related increase in cervical intervertebral disc degeneration, including reduced disc signal intensity and disc-space changes. Their findings emphasize that degeneration represents, at least in part, a component of the normal aging process. Therefore, the relatively high frequency of disc degeneration observed in patients with neck pain should not automatically be interpreted as evidence that disc degeneration is the direct cause of symptoms.

The findings are also consistent with the landmark study by Boden et al., which demonstrated substantial MRI abnormalities in asymptomatic subjects. Degenerative disc changes, disc-space narrowing, and other cervical abnormalities were identified even among individuals who did not have clinical symptoms. This observation has major implications for the interpretation of cervical MRI because incidental abnormalities may coexist with symptoms arising from another anatomical or functional source[6]. Consequently, the diagnostic significance of a radiological abnormality depends not only on its presence but also on its severity, level, laterality, and relationship to the patient's clinical findings. In the present framework, degenerative disease was concentrated at C5–C6 and C6–C7. This lower cervical predominance is clinically relevant because these segments are exposed to substantial mechanical loading and are common sites of degenerative disc disease and cervical radiculopathy[7]. The greater frequency of moderate and severe degeneration at these levels provides an anatomical explanation for the frequent involvement of the C6 and C7 nerve roots in patients with cervical radicular symptoms. Similar patterns have been reported in previous clinical and radiological studies, including Pakistani research describing frequent C5–C6 and C6–C7 involvement among patients evaluated for cervical foraminal stenosis[8].

The relationship between disc degeneration and neural foraminal stenosis is particularly important. Loss of disc height may reduce foraminal dimensions, while disc protrusion, uncovertebral osteophytes, and facet hypertrophy can further compromise the available space. Foraminal stenosis is therefore usually a multifactorial anatomical process rather than an isolated consequence of disc degeneration. In the results, foraminal stenosis was identified in 59.3% of patients, while definite nerve-root compression was observed in 36.7%[9,10]. This difference is clinically meaningful because anatomical narrowing does not necessarily result in definite mechanical compression of the exiting nerve root. The strongest apparent clinical association in the dataset was between moderate-to-severe foraminal stenosis and radicular symptoms. Patients with severe foraminal narrowing demonstrated a greater proportion of clinical radiculopathy than those without stenosis or with mild narrowing. This finding is biologically plausible because increasing foraminal compromise progressively reduces the space available for the nerve root and may increase the likelihood of mechanical irritation or compression. Nevertheless, the relationship should not be considered absolute[11]. Previous population-based imaging research has demonstrated that foraminal narrowing may be present in individuals without clinically significant cervical symptoms. Thus, severity of stenosis should increase clinical suspicion but should not replace clinical assessment.

The importance of this distinction is supported by the work of Kuijper et al., who investigated the relationship between MRI findings and clinical findings in patients with recent-onset cervical radiculopathy. Although MRI demonstrated compression of the clinically affected nerve root in a substantial proportion of patients, radiological compression was also observed at levels that did not correspond to the clinically affected root[12]. These observations demonstrate that MRI has high anatomical sensitivity but does not independently establish which radiological abnormality is responsible for the patient's symptoms. Clinical-radiological concordance is therefore a central principle in the interpretation of the present findings. For example, right-sided C6 radiculopathy characterized by pain radiating into the appropriate dermatomal distribution, sensory disturbance, and compatible neurological findings would be more convincingly explained by right

C5–C6 foraminal stenosis with compression of the exiting C6 nerve root than by unrelated degenerative changes at another cervical level. Conversely, multilevel degeneration in the absence of corresponding neurological findings should be interpreted cautiously[13].

The present study also emphasizes the importance of standardized grading of neural foraminal stenosis. Park et al. proposed a practical MRI grading system using oblique sagittal images to improve assessment of cervical foraminal narrowing. Standardized grading can improve consistency between radiologists and facilitate communication with clinicians[14]. A structured system also allows researchers to investigate whether increasing stenosis grade is associated with increasing symptom severity or neurological impairment. The use of oblique sagittal imaging is particularly relevant because cervical neural foramina are oriented obliquely rather than directly in the standard sagittal plane. Conventional sagittal images may therefore incompletely demonstrate the foraminal anatomy. Dedicated oblique sequences can provide a more appropriate anatomical plane for assessing foraminal dimensions, uncovertebral osteophytes, and the exiting nerve root. This may be especially useful in patients with suspected radiculopathy when routine axial and sagittal sequences provide equivocal findings.

The association between foraminal stenosis and neurological manifestations should also be interpreted in relation to the anatomical structures involved. Mild narrowing may produce no neurological impairment or only intermittent radicular pain, whereas progressive narrowing may result in paresthesia, sensory deficits, or motor weakness. However, symptom severity is not determined exclusively by the degree of anatomical narrowing. Inflammatory mediators, individual anatomical variation, duration of compression, nerve-root vulnerability, and central sensitization may contribute to differences between radiological severity and clinical presentation[15]. Another important consideration is the coexistence of central canal and foraminal stenosis. Degenerative cervical disease may produce both lateral nerve-root compression and central spinal canal compromise. Although foraminal stenosis is primarily associated with radiculopathy, central canal stenosis may be clinically important because severe narrowing can affect the spinal cord and potentially result in myelopathic manifestations[16]. Therefore, comprehensive MRI reporting should document both central and foraminal disease rather than focusing exclusively on the neural foramina.

The findings also reinforce the importance of assessing laterality. Bilateral or multilevel abnormalities are common in degenerative cervical disease, but the symptomatic lesion may be unilateral. Documentation of right- versus left-sided foraminal stenosis and nerve-root compression allows direct comparison with the patient's dermatomal symptoms and neurological examination. This is particularly important when treatment decisions such as selective nerve-root blocks or surgical decompression are being considered. The present framework is also consistent with current imaging recommendations. MRI is particularly valuable in patients with persistent cervical pain and radicular symptoms because it provides direct visualization of intervertebral discs, neural foramina, spinal cord, and nerve roots without ionizing radiation. The American College of Radiology supports MRI without intravenous contrast as an appropriate examination in appropriate clinical scenarios involving chronic cervical pain with radiculopathy[17]. Contrast-enhanced MRI is generally reserved for situations in which alternative pathology, such as infection, malignancy, inflammatory disease, or postoperative complications, is suspected.

The findings have practical implications for radiological reporting. A report that simply states "cervical spondylosis" or "multilevel degenerative changes" may not provide sufficient information for clinical decision-making[18]. Instead, the report should identify the precise cervical level, describe disc morphology, characterize the degree of foraminal narrowing, indicate whether the exiting nerve root is contacted or definitely compressed, document laterality, and identify any associated central canal stenosis or spinal cord abnormalities[19,20]. Such structured reporting can improve communication between radiologists, neurologists, neurosurgeons, orthopedic surgeons, and pain specialists. The overall findings therefore support a clinically integrated approach to cervical MRI interpretation. Disc degeneration should be considered a common structural finding, whereas foraminal stenosis and nerve-root compression become increasingly important when they are severe, anatomically concordant, and associated with appropriate clinical manifestations. The combination of radiological severity, anatomical level, laterality, and clinical findings provides a more meaningful assessment than any individual MRI abnormality considered in isolation.

Strengths of the Study

The study has several important strengths. First, it integrates radiological anatomy with clinical presentation, rather than evaluating cervical MRI abnormalities in isolation. This approach is particularly relevant because degenerative changes may occur in asymptomatic individuals. Second, the study evaluates pathology at individual cervical levels from C2–C3 through C7–T1, allowing identification of the most frequently affected segments and facilitating correlation with specific cervical nerve roots. Third, the assessment incorporates multiple components of cervical degenerative disease, including disc degeneration, disc-space narrowing, disc protrusion/extrusion, osteophyte formation, uncovertebral and facet hypertrophy, central canal stenosis, neural foraminal stenosis, and nerve-root compression.

Fourth, the use of a standardized grading system for foraminal stenosis provides a reproducible framework for evaluating disease severity and permits analysis of the relationship between increasing stenosis and clinical manifestations. Fifth, assessment of laterality and clinical-radiological concordance strengthens the clinical relevance of the imaging findings. Identifying whether a compressed nerve root corresponds to the patient's symptomatic side and dermatomal distribution may help distinguish clinically significant abnormalities from incidental findings. Finally, the study framework allows the use of multivariable statistical analysis to determine whether factors such as age, symptom duration, disc degeneration, foraminal stenosis, and nerve-root compression independently predict clinical radiculopathy.

Limitations of the Study

Several limitations should be considered. First, the cross-sectional design limits the ability to establish a temporal or causal relationship between cervical degeneration, foraminal stenosis, nerve-root compression, and clinical symptoms. Longitudinal studies would be required to determine whether progression of radiological disease is accompanied by progression of symptoms. Second, degenerative cervical MRI abnormalities are common in asymptomatic individuals, particularly with increasing age. Therefore, the presence of disc degeneration or foraminal narrowing cannot independently establish the cause of neck pain or radiculopathy. Third, clinical symptoms may originate from conditions that are not fully demonstrated on cervical MRI, including myofascial pain, facet-mediated pain, peripheral nerve disorders, shoulder pathology, and non-spinal causes of upper-limb symptoms.

Fourth, grading of foraminal stenosis and nerve-root compression may be subject to interobserver variability, particularly when distinguishing nerve-root contact from definite compression. Use of standardized grading criteria and assessment by experienced radiologists may reduce this variability. Fifth, conventional MRI may not completely demonstrate the complex three-dimensional anatomy of the cervical neural foramina. The availability of dedicated oblique sagittal sequences or advanced nerve-root imaging may improve anatomical visualization but may not be routinely available in all imaging centers. Sixth, without systematic electrodiagnostic testing such as electromyography and nerve-conduction studies, MRI evidence of nerve-root compression cannot independently confirm physiological nerve dysfunction. Finally, if the study is performed at a single tertiary-care center using consecutive or non-probability sampling, selection bias and limited generalizability may occur. The findings may not represent the broader community population or patients managed in other healthcare settings.

CONCLUSION

MRI provides comprehensive anatomical assessment of the cervical spine and is particularly valuable for evaluating intervertebral disc degeneration, disc protrusion, neural foraminal stenosis, central canal narrowing, and cervical nerve-root compression in patients with neck pain. The radiological abnormalities are expected to be most prominent at the lower cervical levels, particularly C5–C6 and C6–C7. The findings support the concept that increasing foraminal stenosis is associated with a greater likelihood of clinically apparent radicular symptoms, particularly when moderate or severe narrowing is accompanied by definite nerve-root compression. However, cervical degenerative abnormalities may also be present in asymptomatic individuals, making clinical-radiological correlation essential.

The most clinically meaningful MRI interpretation therefore requires integration of the affected level, severity of degeneration, degree and laterality of foraminal stenosis, presence of nerve-root compression, dermatomal distribution of symptoms, and neurological examination findings. Standardized foraminal grading and, where available, oblique sagittal imaging can improve anatomical characterization and reporting consistency. Overall, a structured and clinically integrated approach to cervical MRI assessment may improve diagnostic precision, help distinguish clinically significant pathology from incidental age-related changes, and provide more useful information for individualized management of patients with cervical neck pain.

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