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Original Research Article

A STUDY ON THE COMMON CAUSES OF LUMBAR NEURAL FORAMINAL STENOSIS IN PATIENTS WITH NEUROLOGICAL BACK PAIN – RADIOLOGICAL AND ORTHOPAEDIC PERSPECTIVE

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ABSTRACT

Background: Lumbar neural foraminal stenosis is a common cause of lower back pain and radiculopathy. Degenerative changes affecting the discs, ligaments, and facet joints vary across age groups. MRI allows for a detailed evaluation of these structural causes. This study aimed to determine the prevalence, severity, etiological factors, and age-related patterns of lumbar neural foraminal stenosis using magnetic resonance imaging. **Materials and Methods:** This cross-sectional MRI-based study was conducted at the MRI Department of the Departments of Orthopaedics and Traumatology and Radiodiagnosis at Madurai Medical College in a tertiary care radiology centre. Lumbar spine MR images were systematically reviewed, and the neural foramina were assessed for the presence, grade, and cause of stenosis using a standardised grading system. A total of 50 patients, comprising 500 lumbar neural foramina, were evaluated, and the data were analysed using descriptive statistics. **Result:** Lumbar neural foraminal stenosis was identified in 136 of the 500 foramina (27.2%). Moderate stenosis was the most common grade, followed by severe and mild stenosis. Disc pathology was the predominant cause, responsible for 98 (72.1%) stenotic foramina. Among disc-related causes, diffuse disc bulging was more frequent than disc protrusion. Ligamentum flavum hypertrophy accounted for 15.4% of the cases, whereas facet arthropathy contributed 12.5%. Disc bulge and ligamentum flavum hypertrophy were more common in younger adults, whereas facet arthropathy was observed mainly in older patients. **Conclusion:** Lumbar neural foraminal stenosis is commonly encountered on MRI, with moderate stenosis and disc-related pathologies being the most prevalent. Distinct age-related degenerative patterns influence the underlying cause. MRI plays a key role in accurately identifying and characterising these changes, supporting informed clinical decision-making.

INTRODUCTION

Lumbar radiculopathy is a common problem in spinal practice. Approximately 3–5% of the population is affected. This is usually caused by age-related degenerative changes that compress a nerve root in the thecal sac or neural foramen, causing pain that radiates down the leg.[1] Lumbar neural foraminal stenosis commonly causes low back pain with radiation to the leg. It results from degenerative narrowing of the neural exit foramina, which compresses the exiting nerve root and is clearly seen on MRI of the lumbar spine.[2] Foraminal stenosis compresses the exiting nerve root and causes radicular pain. It is often missed during lumbar decompression surgery, which can lead to ongoing symptoms and the need for additional surgery. Proper foraminal decompression is important to relieve pain while maintaining spinal stability.[3] Patients with lumbosacral radiculopathy commonly complain of low back pain that radiates to the leg. The pain may be associated with numbness, sensory loss, or weakness in the affected dermatome or myotome, depending on the level of nerve root involvement.[4]
The lumbar spine is composed of five vertebrae, labelled L1 to L5, and forms the lower portion of the spinal column. In this region, spinal nerve roots descend and exit the vertebral canal, supported by surrounding bone, cartilage, and ligaments that help maintain normal lumbar spine function.[5] The lumbar neural foramen is bordered above and below by the adjacent vertebral pedicles, in front by the intervertebral disc and vertebral bodies, and behind by the ligamentum flavum along with the superior

and inferior facet joints.[6] Even a small decrease in the width or height of the neural foramen, caused by disc degeneration or thickening of the ligamentum flavum, can compress the exiting lumbar nerve root and lead to radicular symptoms.[7]

Degenerative changes, such as disc degeneration, disc bulging, and facet joint alterations, become more common with increasing age and are often seen in older individuals, even when no symptoms are present.[8] MRI provides clear visualisation of intervertebral discs, ligaments, epidural fat, and nerve roots. Sagittal images are particularly useful for evaluating foraminal height, foraminal fat loss, and direct compression of the exiting lumbar nerve root. MRI-based grading systems are used to standardise the assessment of lumbar foraminal stenosis. Grading methods that consider both fat obliteration and nerve root compression are more useful for clinical reporting and treatment planning.[9]

Most studies on lumbar spinal stenosis have focused primarily on central canal stenosis. Foraminal stenosis is less frequently discussed, even though it is a common cause of radicular symptoms. Foraminal stenosis is mentioned less frequently in the literature, even though it commonly produces radicular symptoms. The contributions of disc degeneration, facet joint changes, and ligamentum flavum hypertrophy to foraminal narrowing are not well defined. This lack of detail affects accurate diagnosis and limits the effective planning of targeted treatment for patients with lumbar foraminal involvement. Therefore, this study aimed to evaluate the common MRI-detected causes of lumbar neural foraminal stenosis and their relevance in guiding clinical decision-making for the management of low back pain.

MATERIALS AND METHODS

A prospective observational study was conducted on 50 patients at the Departments of Orthopaedics, Traumatology, and Radiodiagnosis, Madurai Medical College, Madurai. Ethical committee approval was obtained, and informed consent was obtained from all the patients.

Inclusion and exclusion criteria

Adult patients >18 years of age with low back pain and radicular symptoms who showed MRI evidence of lumbar neural foraminal stenosis of grades 1 to 3 involving the lumbar levels were included.

Patients <18 years of age, those with prior lumbar spine surgery, spinal infection or tumour, grade 0 foraminal stenosis on MRI, and those with spondylolisthesis, acute spinal trauma, or fractures were excluded.

Methods: The primary exposure assessed was lumbar neural foraminal stenosis, as detected on magnetic resonance imaging. The neural foramen is an interpedicular bony opening with three zones: the entrance or internal zone, mid or intraforaminal zone, and exit or extraforaminal zone. It is oval or inverted teardrop-shaped. The foraminal height is usually approximately 20–23 mm, and the superior foramen measures approximately 8–10 mm in width. Nerve root compression is observed when the foraminal height is <15 mm and the posterior disc height is ≤ 4 mm, indicating foraminal stenosis.

In a normal adult spine, the ligamentum flavum thickness ranges from 2.5 mm to 3.4 mm. Ligamentum flavum hypertrophy was considered when the thickness was ≥ 3.5 mm.

The primary outcome was the MRI grade of lumbar neural foraminal stenosis based on the grading system of Lee et al.9 All MRI examinations were performed using a standard protocol. MRI images were evaluated by a radiologist with expertise in musculoskeletal imaging. Grade 1: Mild stenosis with perineural fat obliteration in two opposite directions without any change in nerve root morphology. Grade 2: Moderate stenosis with perineural fat obliteration in all four directions without nerve root morphological changes. Grade 3: Severe stenosis with nerve root collapse or morphological alteration.

Data were analysed using SPSS version 29, and the results were expressed as frequencies and percentages.

RESULTS

A total of 50 patients were screened and included in the study, with no exclusions or dropouts noted. Foraminal stenosis was identified in 136 of the 500 neural foramina (27.2%). The neural foramina were evaluated at all lumbar levels from L1–L2 to L5–S1. Grade 2 stenosis was the most common, seen in 62 foramina (45.6%), followed by grade 3 in 43 (31.6%) and grade 1 in 31 (22.8%) [Figure 1]. The representative MRI findings are illustrated in Figures 2 and 3. Disc pathology was the predominant cause in 98 foramina (72.1%), comprising diffuse disc bulge in 56 foramina (41.2%) and disc protrusion in 42 foramina (30.9%). Ligamentum flavum hypertrophy accounted for 21 foramina (15.4%), and facet arthropathy was observed in 17 foramina (12.5%) [Figure 2]. Diffuse disc bulge was most frequently observed in the 30–45-year age group (90.4%), with equal distribution in patients younger than 30 years (4.8%) and older than 45 years (4.8%). Disc protrusion was most common in the 30–45-year age group (43% cases). Facet arthropathy was observed exclusively in patients older than 60 years (100%). Ligamentum flavum hypertrophy was most frequently observed in the 30–45-year age group (47.6%) [Figure 3&Table 1].

Table 1: Distribution of lumbar neural foraminal stenosis

Parameter		Number of foramina / patients (n, %)
Total patients		50
Total neural foramina examined		500
Neural foramina with stenosis		136
Grade 1 foraminal stenosis		31
Grade 2 foraminal stenosis		62
Grade 3 foraminal stenosis		43
Predominant cause – disc pathology		98 foramina
Diffuse disc bulge		56
Disc protrusion		42
Predominant cause – ligamentum flavum hypertrophy		21
Predominant cause – facetal arthropathy		17
Age range of patients		26–72 years
Disc bulge distribution	30–45 years	90.4%
	<30 years	4.8%
	>45 years	4.8%
Disc protrusion distribution	30–45 years	43%
	45–60 years	22%
	>60 years	29%
	<30 years	6%
Facetal arthropathy		observed only in patients >60 years
Ligamentum flavum hypertrophy distribution	30–45 years	47.6%
	45–60 years	33.3%
	>60 years	19%

Figure 1: Comparison of normal vs stenosed neural foramina in the same patient

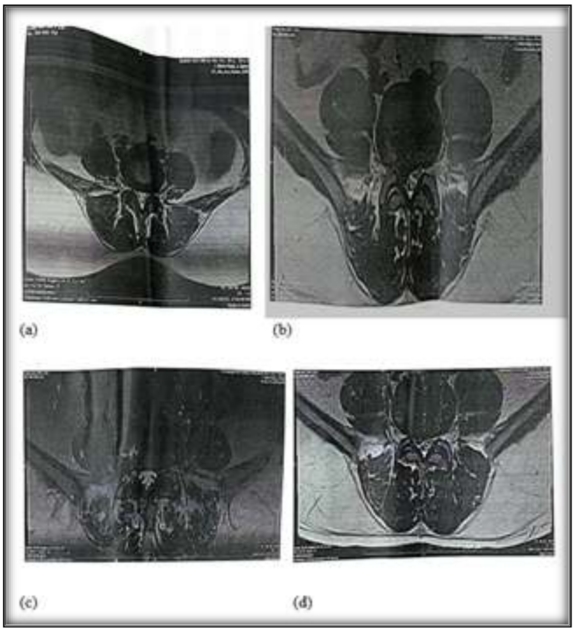

Figure 2: (a) Diffuse disc bulge causing bilateral neural foraminal stenosis, (b) Disc protrusion causing neural foraminal stenosis, (c) Facetal joint arthropathy causing neural foraminal stenosis, (d) Ligamentum flavum hypertrophy causing neural foraminal stenosis

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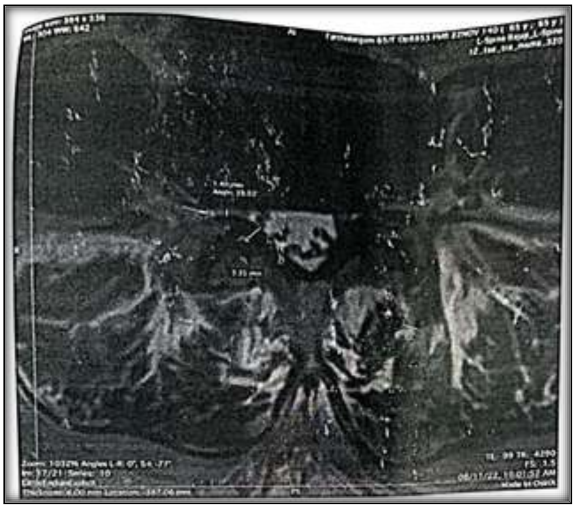

Figure 3: Ligamentum flavum hypertrophy and facetal arthropathy causing neural foraminal stenosis

DISCUSSION

In this study, lumbar neural foraminal stenosis was common, and moderate stenosis was the most frequently observed. Disc pathology was the main cause, mostly due to diffuse disc bulging. Ligamentum flavum hypertrophy and facet arthropathy are less common causes. Disc bulge and ligamentum flavum hypertrophy were more commonly observed in younger adults, whereas facetal arthropathy was only observed in older patients, showing age-related degenerative changes.

Lumbar neural foraminal stenosis was commonly observed, with moderate severity being the most frequent, followed by severe and mild forms. Disc-related pathology has emerged as the principal etiological factor, accounting for the majority of stenotic foramina. Similarly, Lee et al. found that MRI assessment of 576 lumbar neural foramina identified foraminal stenosis in 46 foramina (8.0%), with grades 1–3 detected consistently by two independent readers.10 Kim et al. reported that the study evaluated 31 patients with MRI-confirmed moderate to severe lumbar neural foraminal stenosis, representing 100% of the study population.11 Binoj et al. in 127 patients with degenerative disc disease, MRI grading showed Grade 2 foraminal stenosis as the most common severity, followed by Grade 3 and Grade 1 stenosis, indicating predominance of moderate disease.12 Sartoretti et al. among 966 lumbar neural foramina, moderate stenosis (Grade C) was most common (25.2–25.7%), followed by advanced stenosis (Grade D) in 11.7–12.4%, indicating predominance of intermediate-grade disease.[13] Differences in prevalence across studies may be related to variations in study design, sample size, age distribution, and MRI grading criteria.

Similarly, Lee et al., in a cohort of 133 patients, disc-related pathology was present in 70.4% of L4/L5 and 74.1% of L5/S1 neural foramina stenosis cases, indicating disc pathology as the predominant contributor to foraminal narrowing.10 Ushio found that, in contrast to our study, where disc pathology was the predominant cause of foraminal stenosis, demonstrated ligamentum flavum ossification as the primary cause, with no associated disc pathology identified.[14] These studies support our findings by showing that lumbar foraminal narrowing is usually moderate in severity and most often caused by disc-related changes. Although some reports describe other causes, the overall pattern consistently supports disc pathologies as the primary contributor.

In this study, among disc-related aetiologies, diffuse disc bulge predominated disc protrusion. Ligamentum flavum hypertrophy and facet arthropathy were less frequent contributors. Disc bulge and ligamentum flavum hypertrophy were common in younger adults, whereas facet arthropathy occurred in older patients. These patterns likely reflect the progression of degenerative changes with advancing age, with early disc involvement preceding the facet joint degeneration. Gebrewold and Tesfaye found that in a study of 72 patients, disc bulge was the most frequent disc-related MRI finding, present in 81.9% of cases, while disc herniation was identified in 41.7%.[15] Karki et al. in a large series of lumbar spine MRIs, disc bulge was the most frequent disc-related finding, seen in 1,667 patients (81.8%), while disc herniation was observed in 1,032 patients (50.6%), indicating a higher prevalence of diffuse bulging.[16] Cheung et al. in a cohort of 34 patients, ligamentum flavum hypertrophy was evident at stenotic levels, with mean thickness ranging from 3.8 to 4.6 mm at L4–5 and L5–S1, supporting its role in lumbar foraminal stenosis.[17]

Similarly, Lee et al., in a study of 133 patients, found facet hypertrophy in 9 of 44 L4/L5 neural foraminal stenosis cases (20.4%) and 11 of 62 L5/S1 cases (17.7%).[10] Karki et al. reported that in a large cohort, disc bulge was most prevalent in the 41–50-year age group (24.0%), followed by 31–40 years (22.9%) and 51–60 years (18.2%), indicating peak occurrence in middle age.[16] Perolat et al. found that facet joint degeneration increases with age, with studies reporting near-universal facet arthropathy in individuals older than 60 years and much lower prevalence in younger populations.[18] Kumar et al. found that ligamentum flavum thickness increased significantly with age, peaking in patients aged 31–40 years (38.3%), followed by 41–50 (25%) and 51–60 years (23.3%), indicating age-related hypertrophy.[19] These studies support our findings that they show the same pattern: disc bulge is most common, ligament thickening increases with age, and facet joint disease mainly affects older people, confirming that our findings are consistent with previous research.

Strengths: The strength of this study is in the detailed MRI-based evaluation of foraminal stenosis with clear grading, etiological analysis, and age-related pattern assessment. The use of a validated MRI grading system further strengthens the methodological reliability of this study.

Limitations: The study was limited by being conducted at one centre, having no follow-up, a lack of symptom correlation, and possible reader variation, which may affect the wider applicability and clinical interpretation of the findings.

CONCLUSION

Lumbar neural foraminal stenosis was frequently observed in this study, with moderate stenosis being the most common severity grade. Disc-related pathology, particularly diffuse disc bulge, was the predominant cause of foraminal narrowing, whereas ligamentum flavum hypertrophy and facet joint arthropathy were less frequent contributors. Distinct age-related patterns were observed for different aetiologies. This study adds to the existing evidence by providing a structured MRI-based assessment of the severity and causes of lumbar neural foraminal stenosis. Future studies with larger, multicentre cohorts, longitudinal follow-up, and clinicoradiological correlation are required to further understand disease progression and clinical relevance.

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