Original Research Article

Measurement of Lumbar Spinal Canal Diameter in the Indian Population Using MRI: A Retrospective Study at a Tertiary Care Hospital in Mandya

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ABSTRACT

Background
Lumbar spinal canal stenosis (LSCS) is a common degenerative spinal condition, and its diagnosis relies significantly on accurate assessment of spinal canal dimensions. Population-specific reference values are essential, especially in diverse regions like India where normative data remain limited.

Objective
To evaluate the anteroposterior (AP) diameter of the lumbar spinal canal using MRI and identify gender-based differences among patients at a tertiary care hospital in Mandya, India.

Methods
This was a retrospective study conducted using MRI scans of 54 adult patients (22 males, 32 females) from the hospital's imaging archives. Measurements of the AP diameter were taken at five lumbar levels (L1-L2 to L5-S1) using T2-weighted axial and sagittal images. Descriptive statistics and independent t-tests were used to analyse the data.

Results
Significant gender-based differences were observed at the L2-L3 and L3-L4 levels, where females exhibited larger mean AP diameters compared to males ($p = 0.003$ and $p = 0.002$, respectively). A marginally significant difference was noted at L4-L5 ($p = 0.051$). No significant differences were found at L1-L2 or L5-S1. The mean AP diameter at L4-L5 in males (0.90 cm) was below the commonly accepted threshold for stenosis, suggesting a higher risk of LSCS in this subgroup.

Conclusion
This study highlights important gender-specific anatomical differences in lumbar spinal canal dimensions in the Indian population. These findings underscore the need for localized reference standards to aid in the early diagnosis of LSCS. Further multicentric research with larger sample sizes is recommended to validate these observations.

Keywords: Lumbar spinal canal, MRI, spinal stenosis, AP diameter, gender differences, Indian population.

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INTRODUCTION

Lumbar spinal canal is a critical anatomical structure that houses and protects the spinal cord and nerve roots. It is formed by the vertebrae, intervertebral discs, and supporting ligaments, with its dimensions varying across populations. The normal anteroposterior (AP) diameter of the lumbar spinal canal typically ranges from 15–27 mm. A diameter less than 12 mm is indicative of spinal canal stenosis, whereas a diameter below 10 mm is considered definitive for stenosis, a condition that leads to nerve root compression and subsequent neurological symptoms.[1]

Lumbar spinal canal stenosis (LSCS) is a degenerative condition characterized by the progressive narrowing of the spinal canal. It is commonly associated with aging and degenerative changes in the spine, leading to neurogenic claudication, radiculopathy, and chronic lower back pain. The prevalence of LSCS is increasing, making it a major cause of disability in older adults.[2] The identification of variations in spinal canal dimensions is critical for early diagnosis and appropriate management of this condition.

Magnetic resonance imaging (MRI) is currently the gold standard for evaluating spinal pathology due to its superior soft-tissue contrast and multiplanar imaging capabilities.[3] Studies have shown that changes in the AP diameter of the spinal canal are strong predictors of LSCS. Malghem et al. (2009) demonstrated that MRI is more accurate than CT scans in assessing lumbar canal stenosis, highlighting its superiority in non-invasive spinal evaluation.[4] However, limited data are available regarding the normal lumbar spinal canal dimensions in the Indian population. Establishing baseline measurements for this population will improve diagnostic accuracy and enhance clinical decision-making in LSCS management.[5]

This study aims to determine the AP diameter of the lumbar spinal canal in symptomatic and asymptomatic individuals using MRI at a tertiary care hospital in Mandya. The findings might help establish standard reference values and identify at-risk individuals for LSCS in the Indian population.

MATERIALS & METHODS

This retrospective record-based study was conducted in the Department of Radiodiagnosis at the Mandya Institute of Medical Sciences between August 2023 and July 2024. The study utilized pre-existing MRI scan data from the hospital's Picture Archiving and Communication System (PACS). These scans were originally acquired for patients presenting with lower back pain.

Following approval from the Institutional Ethics Committee, the MRI scans of the lumbosacral spine were retrieved and analysed. The anteroposterior (AP) diameter of the spinal canal was measured at different lumbar vertebral levels. Patient demographics, including age, gender, and clinical symptoms, were documented in a structured proforma for further analysis.

The study included patients who had undergone MRI scans of the lumbosacral spine at the tertiary care hospital. The calculated minimum sample size was 54 for $Z1-\alpha/2=1.96$ (95% CI), $\sigma=1.22$, $d=2.5\%$ & Mean AP diameter of 13 mm. However, convenience sampling method was used, selecting all eligible MRI scans within the study period that met the inclusion criteria.

Inclusion/Exclusion Criteria

Data of patients of either gender, aged 18 years and above who underwent MRI scans of the lumbosacral spine at the hospital were included. Patients with pre-existing spinal abnormalities,

such as Spondylolisthesis (vertebral slippage), Pott's disease (tuberculous spondylitis), Patients with a history of spinal surgery, as surgical alterations could affect spinal canal dimensions were excluded from the study.

Data Collection and Imaging Technique

MRI scans were analysed using T2-weighted axial and sagittal images to measure the AP diameter of the spinal canal. Standard radiological landmarks were used for consistent measurements. The collected data, including spinal canal dimensions, clinical symptoms, andpatient demographics, were recorded in a excel sheet for statistical evaluation.

Statistical Analysis

All data were entered into Microsoft Excel and analysed. Descriptive Statistics was used, data was presented in mean and standard deviation (SD) to summarize continuous variables, & proportions and percentages were used to describe categorical variables. Independent t-test applied to compare mean AP diameters between male & female patients.

RESULTS

The study analysed records of 54 patients who underwent MRI scans of the lumbar spine at a tertiary care hospital. Age & gender distribution of the patients are mentioned below (Table 1).

	Male	Female
Gender	22 (40.7 %)	32 (59.2%)
Age (Years)	48.3 ± 14.7	48.3 ± 14.1

Table 1: Patient Demographics

Anteroposterior (AP) Diameter of the Lumbar Spinal Canal. The mean AP diameter of the lumbar spinal canal at different vertebral levels was compared between males and females. The results are summarized below:

Spinal Level	Male (Mean ± SD, cm)	Female (Mean ± SD, cm)	p-value
L1-L2	1.80 ± 2.47	1.42 ± 0.23	0.387
L2-L3	1.16 ± 0.30	1.38 ± 0.22	0.003
L3-L4	1.00 ± 0.28	1.24 ± 0.26	0.002
L4-L5	0.90 ± 0.31	1.06 ± 0.26	0.051
L5-S1	1.03 ± 0.19	1.30 ± 1.33	0.360

Table 2: Mean Anteroposterior diameter of lumbar spinal canal

Statistically significant differences in AP diameter were found at the L2-L3 ($p = 0.003$) and L3-L4 ($p = 0.002$) levels, where females had a significantly larger AP diameter than males. At L4-L5, the difference was marginally significant ($p = 0.051$), suggesting a trend towards wider spinal canals in females at this level as well. No significant differences were observed at L1-L2 ($p = 0.387$) and L5-S1 ($p = 0.360$) between the genders.

Figure 1 & 2: spinal canal stenosis on MRI images of male and female patient respectively

DISCUSSION

This study evaluated AP diameter of the lumbar spinal canal in using MRI scans and found statistically significant gender-based variations at L2-L3 and L3-L4 levels, where females had larger canal diameters than males. A marginally significant difference was observed at L4-L5, indicating a possible trend. No significant differences were found at L1-L2 and L5-S1 levels. These findings suggest that gender-based anatomical differences may play a role in lumbar spinal canal morphology, which has implications for diagnosing and managing lumbar spinal stenosis (LSS).

Several studies have explored lumbar spinal canal morphology, and our findings align with and expand upon previously published data. Previous research has established that males generally have a larger vertebral body size, whereas females tend to have a wider spinal canal in certain regions. Kang et al. (2013) reported that females had a significantly wider AP diameter at mid-lumbar levels, a finding consistent with our results.[6] Similarly, Pawar et al. (2014), in an MRI-based study on the Indian population, reported an average L3-L4 AP diameter of 1.12 cm, closely matching our values (1.00 ± 0.28 cm in males and 1.24 ± 0.26 cm in females).[5]

LSS is a common degenerative condition where narrowing of the spinal canal leads to neurogenic claudication and lower back pain. The AP diameter is a key diagnostic parameter in identifying LSS. Studies suggest that an AP diameter < 1.0 cm at L4-L5 is associated with spinal stenosis.[1] Our findings show that the mean AP diameter at L4-L5 in males is 0.90 cm, which falls below this threshold, indicating a potentially higher risk of LSS in men.

Several studies have highlighted population-specific differences in lumbar spinal canal dimensions. Hashemi et al. (1994) reported that Western populations tend to have larger spinal canals compared to Asian populations.[7] Hukins et al. (1990) found that Caucasian populations had an L4-L5 AP diameter averaging 1.3 cm, whereas East Asians and South Asians had narrower spinal canals.[8] Our study reinforces the importance of ethnic and population-specific reference values when diagnosing LSS.

MRI is considered the gold standard for assessing spinal canal stenosis due to its superior soft tissue contrast. Malghem et al. (2009) compared MRI and CT measurements, concluding that MRI provides more accurate and reproducible spinal canal measurements, supporting its use in this study.[4]

Despite the considerable outcomes, study had several limitations, firstly, single-center study with a limited sample size (n=54), restricting generalizability. However, the study had

sufficient power to analyse intergroup difference. Lack of age-based stratification, as spinal dimensions may change with aging. No interobserver validation, which may introduce minor measurement biases. No clinical symptom correlation, limiting conclusions on the functional impact of anatomical differences. The had certain strengths, the study evaluated gender-based variations in lumbar spinal canal dimensions using MRI in an Indian cohort. Clinical relevance in identifying high-risk groups for lumbar spinal stenosis. Use of MRI, ensuring high measurement accuracy compared to X-ray or CT-based studies.

CONCLUSION

To conclude, the study highlights significant sex-based differences in lumbar spinal canal dimensions, with females having a larger AP diameter at L2-L3 and L3-L4 compared to males. Future studies with larger sample sizes can further validate these anatomical variations and their clinical implications.

Sponsor: None
Conflicts of Interest: None

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