
Assessing Lumbar Spinal Canal Stenosis on MRI Using Lee's Classification System*

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ABSTRACT

Lumbar spinal canal stenosis is the compression of the central lumbar spinal canal caused by degenerative changes such reduction of the disc height with or without bulging of the intervertebral disc, hypertrophy of the ligamentum flavum, spurs and facet joints. The use of MRI plays a vital role in the diagnosis of lumbar central canal stenosis. There have been studies associating MRI grading with patient's neurological impairment. However, there is still no standard diagnostic criteria or grading systems for spinal canal lumbar stenosis using MRI, causing discrepancies in the radiological reports with poor correlation in patients' clinical symptoms.

One promising study was made by Lee GY (2011) which proposes a novel classification of the lumbar spinal canal stenosis. The study suggested that primary cause of symptoms of the lumbar spinal canal stenosis is the encroachment of cauda equina nerve roots (with size of the spinal canal). With that, they made the classification according to cauda equina shape into four grades based on T2 weighted axial images. However, no local study or research was done to support this classification. The aim of this study was to evaluate the reproducibility of the Lee classification system in assessing lumbar spinal canal stenosis using the local population

This retrospective study involved 50 years old and above patients who underwent lumbar magnetic resonance imaging. Lumbar MRI Axial T2 images of patients from 2018-2020 who met the inclusion criteria were reviewed by three radiologists. A teaching file created by the researcher explained the definition and criteria of the Lee system. These criteria were used by these radiologists in their grading of the obtained images. Interobserver agreement between the examining radiologists was analyzed for grading of lumbar spinal canal stenosis using the Fleiss' kappa. ICC reliability was categorized as slight (0-0.20), fair (0.21-0.40), moderate (0.41-0.60), substantial (0.61-0.80), and excellent (0.81-1.00).

Using Fleiss' kappa, average inter-observer agreements of per level in relation to the proposed grading classification were observed. The following are the averages per level: L3-4 with an average kappa of 0.5557; L4-5 with an average kappa of 0.7179; and L5-S1 with an average kappa of 0.5985. The total average kappa of all lumbar levels is 0.6240. With that, the inter-observer agreement in the grading of lumbar spinal canal stenosis among the three readers was substantial agreement.

Key words: Lumbar spinal cord stenosis, Lee's classification system, Fleiss kappa

Lumbar spinal canal stenosis is the compression of the lumbar spinal canal caused by degenerative changes such reduction of the disc height with or without bulging of the intervertebral disc, and hypertrophy of the ligamentum flavum and facet

joints. With this, the patient is prone to have associated neurological complications such as radicular pain, neurological intermittent claudication, sensory and motor disturbances in the lower extremities.

MRI plays a vital role in the diagnosis of lumbar spinal canal stenosis. There have been studies associating MRI grading with patient's neurological impairment.² Nevertheless, there is still no standard diagnostic criteria or grading systems for lumbar spinal canal stenosis using MRI, causing discrepancies

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in the radiological reports with poor correlation in patients' clinical symptoms.³

One promising study was made by Lee GY (2011) which proposes a novel classification of the lumbar spinal canal stenosis. The study suggested that primary cause of symptoms of the lumbar spinal canal stenosis is the encroachment of cauda equina nerve roots. With that, they made the classification according to cauda equina shape into four grades based on T2 weighted axial images.⁴ However, no local study or research was done to support this classification.

With that in mind, the researcher aimed to evaluate the reproducibility of the proposed classification system using the local population based on inter-observer agreement.

Literature Review

A wide spectrum of degenerative abnormalities such as degeneration, MODIC changes, disc displacement, ligamentum flavum hypertrophy and facet joint arthropathy encompasses degenerative disc disease.

One of the associated complications of degenerative diseases are lumbar spinal canal stenosis. It is defined as signal loss in the epidural fat causing nerve root compression within its canal, producing radicular symptoms to the patient. One of the most common locations of spinal canal stenosis is in the lumbar region, particularly in the L4-L5 and L5-S1 regions.⁵

Lumbar spinal canal stenosis is an important pathological entity to recognize in patients with compression of lumbar neural and vascular structures, resulting in various degrees of clinical disability. Multiple studies were done to provide a tool in the assessment of central canal stenosis. The Lee system gained popularity due to its high reliability and reproducibility. It is a four grade classification system based on the degree of separation of the cauda equina on T2-weighted axial MRI with the following grades: Grade 0 which refers to no effacement of the anterior CSF space; Grade 1 or mild lumbar spinal canal stenosis which refers to mild effacement of the anterior CSF space and all cauda equina clearly separated from each other; Grade 2 or moderate lumbar spinal canal stenosis which refers to moderate effacement of the anterior CSF space with aggregation of some cauda equina where it is impossible to identify each other visually; and Grade 3 or severe LCCS which refers

to severe effacement of the anterior CSF space with marked dural sac compression as well as the entire cauda equina.⁶

Objective

The objective of the study was to evaluate the reproducibility of the Lee classification system in assessing lumbar spinal canal stenosis using the local population.

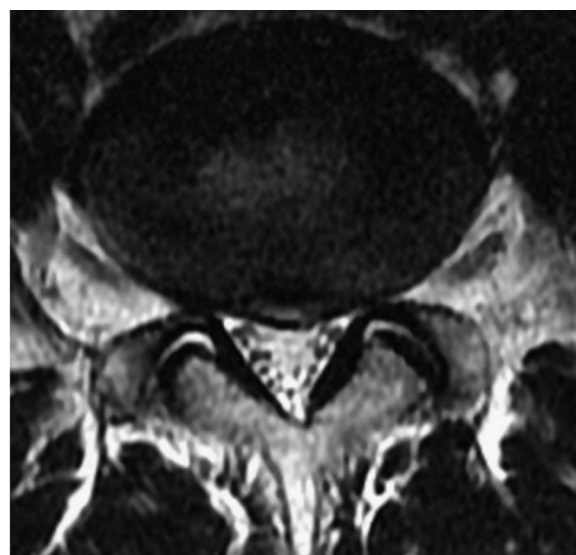


Figure 1. This is an axial T2 weighted turbo spine echo image of the L4-L5 disc of a 49-year-old male with radiating pain. The image shows clear separation of the cauda equina causing mild canal stenosis, which is classified as Grade 1.7

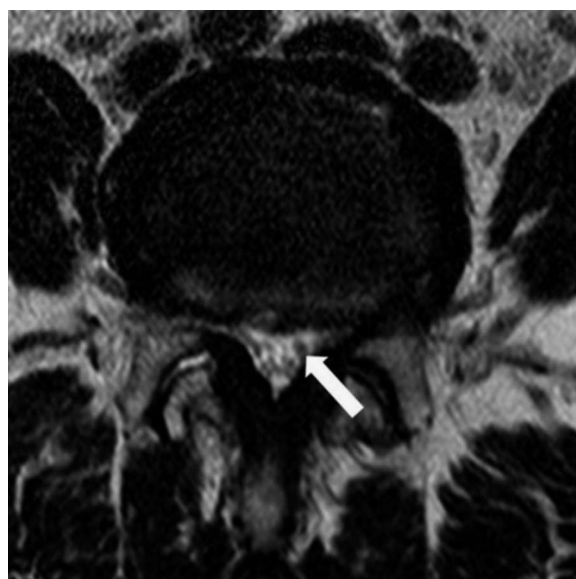


Figure 2. This is an axial T2 weighted turbo spine echo image of the L4-L5 disc of a 79-year-old female with bilateral leg weakness. The image shows moderate canal stenosis with some cauda equina aggregates (arrow) which is classified as Grade 2.7

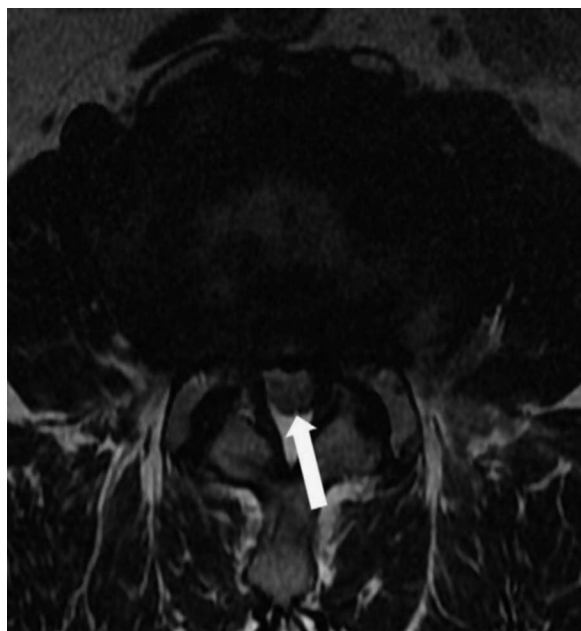


Figure 3. This is an axial Axial T2 weighted turbo spin echo image of the L3-L4 disc of a 67-year-old male with symptoms of lower back pain. The image now shows severe canal stenosis through aggregation of the entire cauda equina, demonstrating a bundle-like appearance (arrow) 7

MATERIALS AND METHODS

Research Design

This retrospective study involved 50 years old and above patients who underwent lumbar magnetic resonance imaging.

Target Population

Fifty years old and above adult patients who underwent lumbar magnetic resonance imaging

Sampling Population

Fifty year old and above adult patients who underwent lumbar magnetic resonance imaging in the Diagnostic Imaging Center of the Department of Radiology from year 2018-2020.

Eligibility Criteria

Inclusion Criteria

All fifty years old and above adult patients who underwent lumbar magnetic resonance imaging in the Diagnostic Imaging Center of the Department of

Radiology from year 2018-2020 with the following criteria.

1. Patient who had no history of trauma or previous spinal operation.
2. Patient who had no history of infection or tumor.

Exclusion Criteria

1. Patient who had history of trauma or previous spinal operation.
2. Patient who had history of infection or tumor.
3. Patient who cannot tolerate the procedure.

Study Procedure

Sampling Methodology

Sampling methodology used was non-probability convenient sampling.

Recruitment of Participants

The study population included patients who underwent lumbar MRI procedure from the year January 2018 up to September 2020

The requirement for informed consent was waived because of the study's retrospective design.

Data Collection

Lumbar MRI Axial T2 images of patients from 2018-2020 who met the inclusion criteria were reviewed by three radiologists: three consultants with at least 10-year experience in Lumbar MRI examination and diplomates of the Philippine Board of Radiology (DPBR). They were blinded by their clinical information and radiological reports.

A teaching file created by the researcher explained the definition and criteria of the Lee system. These criteria were used by the radiologists in their grading of the obtained images.

Lumbar images in T1 and T2 weighted images were obtained in axial plane while T1 and T2 weighted short tau inversion-recovery (STIR) and T2 sagittal images were obtained in supine position.

Instruments Used

All MRI examinations was performed using the same protocol with a 1.5 T magnet (GE Healthcare)

using a syn-spine coil and fast spin echo imaging. Lumbar images in T1 and T2 weighted images were obtained in axial plane (Field of view) while T1 and T2 weighted short tau inversion–recovery (STIR) and T2 sagittal images were obtained in supine position. The following field of view, matrix and slice thickness were used

	Field of View	Matrix	Slice Thickness
Sagittal View	32 cm	512 x 256	3 mm
Axial View	15 cm	256 x 320	3 mm

The MRI sequences used were as follows: sagittal T1 weighted spin echo [repetition time (ms)/echo time (ms) of 500–600/12–17], T2 STIR (2500/60), T2 weighted image (3500/120), axial T2 weighted turbo spin echo (3000–4000/60–150) and T1 weighted turbo spin echo (600–700/10–15).

Sample Size Calculation

Sample size calculation was based on the number of the total population of the people who underwent lumbar MRI examination from the year January 2018–September 2020 with a confidence level of 95% and margin of error of 5%. The computed value based on a total population of 400 was 197 patients.

Data Management and Analysis

Interobserver agreement between the examining radiologists was analyzed for grading of central lumbar spinal canal stenosis using the Fleiss kappa. Fleiss' kappa is a measure of inter-rater agreement used to determine the level of agreement between two or more raters when the method of assessment, known as the response variable, is measured on a categorical scale. ICC reliability was categorized as slight (0–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and excellent (0.81–1.00).

Ethical Consideration

Approval by the ethics committee of FEU-NMRF was obtained prior to the start of the study. Maintaining

the confidentiality of the patients included in the study was one of the top priorities of the researcher. Only MRI lumbar images of each patient included in this study were used. Images were collected, named using research code numbers and saved in a Google drive designated for this research. Only radiologists who did the grading of the obtained images were given the access passwords for the images and be allowed to access the images for the entire duration of the study.

Informed consent was obtained only from those who qualified under the stated criteria but not from vulnerable populations.

The study procedures were minimally risky since only diagnostic images of the patient were used. Health information was not reused or disclosed to any other person except for the participant in the study. Likewise, the possibility of data breach was minimized through data anonymization, password protection and access limitation.

There were no conflicts arising from financial, familiar or propriety considerations of the principal investigator, sponsor or the study site since only a minimal amount of the medical information was obtained. Anonymity of the data was maintained among the radiologists whose purpose was to show the reproducibility of the Lee's criteria in assessing lumbar spinal canal stenosis.

There were no direct risk or compensation for the patients included in the study since only diagnostic images of the patients were used.

Findings of this study are expected to benefit patients who will undergo Lumbar MRI as they provide an avenue for the standardization in the assessment of lumbar spinal canal stenosis.

The principal investigator requested to waive the request for informed consent since minimum amount of protected health information such as MRI lumbar images were only needed to conduct the research.

RESULTS

A total of 197 patients were included in the study with 84 male and 113 females with mean age of 60 years old.

The observations of Reader I, Reader II and Reader III per level (L3–L4, L4–L5 and L5–S1) are presented in Tables 1, 2 and 3. Using Fleiss' kappa, average inter-observer agreements of per level in relation to the proposed grading classification were observed. The following are the averages per lumbar level: L3–4 with an average kappa of 0.5557; L4–5

with an average kappa of 0.7179; and L5–S1 with an average kappa of 0.5985. The total average kappa of all lumbar levels is 0.6240 (Table 4). With that, the inter-observer agreement in the grading of lumbar spinal canal stenosis between the three readers was substantial (0.61–0.80).

DISCUSSION

Different quantitative or qualitative radiological criteria have been suggested for the assessment of lumbar spinal canal stenosis for many years. Despite tremendous efforts to produce a widely accepted classification system, consensus on normative and clear cutoff values in lumbar spinal canal stenosis has not yet been reached.

In 2011, Lee, et al. suggested a standardized new MRI grading system for lumbar spinal canal stenosis, with classification focusing on the shape of the cauda equina, providing a reliable assessment of lumbar central canal stenosis with interobserver agreement of substantial to almost perfect correlation (from 0.730

to 0.953). The encroachment of the cauda equina with its nerve roots is the primary cause of symptoms, and direct obstruction of blood flow to the cauda equina through encroachment can result in clinical manifestations.⁸

The current study was done involving three readers using Fleiss kappa in assessing the interobserver agreement, using the proposed grading system. Highest agreement among the readers was found at the level of L4–5 with a kappa value of 0.7179. The total average of the kappa values is 0.6243, which is correlated to a substantial agreement. This proposed grading system is easily understood by Filipino radiologists due to its rapid visual assessment without using specific measurement tools. This reason also contributes to the strength of this grading system that can be used further by radiologists as a standard in assessing lumbar spinal canal stenosis.

Limitation of the study includes the correlation of the stenosis with its clinical manifestations. This limitation may provide a clinical validity of the proposed system in relation to the symptoms

Table 1. Interobserver agreement among the readers regarding lumbar spinal canal stenosis at the level of L3-L4

	Grade 0	Grade 1	Grade 2	Grade 3	Total
Kappa	0.6591	0.5928	0.2593	0.7115	0.5557

Table 2. Interobserver agreement among the readers regarding lumbar spinal canal stenosis at the level of L4-L5

	Grade 0	Grade 1	Grade 2	Grade 3	Total
Kappa	0.7115	0.4643	0.8661	0.8295	0.7179

Table 3. Interobserver agreement among the readers regarding lumbar spinal canal stenosis at the level of L5-S1

	Grade 0	Grade 1	Grade 2	Grade 3	Total
Kappa	0.4643	0.5694	0.5238	0.8295	0.5968

Table 4. Total interobserver agreement among the readers regarding lumbar spinal canal stenosis on L3-L4, L4-L5 and L5-S1

	L3-L4	L4-L5	L5-S1	Total
Kappa	0.5557	0.7179	0.5968	0.6234
p-value	0.002	0.001	0.001	0.012

of the patient through the help and assessment of a Neurologist and/or Orthopedic Surgeon. Another limitation is that only a single posture (spine position) was evaluated. Future researchers have to assess it in the flexed or extended position in order to evaluate positions that may cause encroachment in the cauda equina.

CONCLUSION

The interobserver agreement (Fleiss Kappa) of the study using the new grading system of lumbar spinal canal stenosis was a substantial agreement. With the given result, this study will help provide an appropriate diagnosis and treatment of patients. Clinical correlation using the proposed grading system as well as assessing the patient in different lumbar postures is recommended.

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