Year 2023-2025 HAMAD AHSANSU91-MSAHW-S23-102 FAHS

Comparative analysis of LEE and SCHIZAS grading systems in the MRI-based diagnosis of lumbar canal stenosis

SUPERIOR UNIVERSITY

Thesis Submitted to

The Superior University Lahore

In Partial Fulfillment of the

Requirement for the Degree of

Master of Science in Allied Health Sciences

By

HAMAD AHSAN

Roll No. SU91-MSAHW-S23-102

Session: 2023-2025

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No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University, Lahore in partial fulfillment of the requirements for the degree of Master of Science in the field of "**Allied Health Sciences"** in Faculty of Allied Health Sciences at The Superior University, Lahore.

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DEDICATION

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In the name of Allah, the most Gracious, the most Merciful.

I am extremely thankful to Almighty ‘Allah’ Who is the entire source of knowledge and wisdom endowed to mankind, for providing me with the acumenand vision to complete this endeavor.

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Hamad Ahsan

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LIST OF ABBREVIATIONS

- Lumbar Spinal Stenosis – LSS
- Cauda Equina – CE
- Neurogenic Claudication – NC
- Magnetic Resonance Imaging – MRI
- Lumbar Canal Stenosis – LCS
- Dural Sac – DS
- Cerebrospinal Fluid – CSF
- Grading System – GS
- Interobserver Agreement – IA
- Standard Deviation – SD
- Body Mass Index – BMI
- Oswestry Disability Index – ODI
- Sensitivity – Sens.
- Specificity – Spec.
- Cross-sectional Study – CSS
- Picture Archiving and Communication System – PACS
- Sample Size – SS
- Inclusion Criteria – IC
- Exclusion Criteria – EC
- Statistical Analysis – SA
- Functional Impairment – FI

ABSTRACT

Objective

This study evaluates the learnability of two MRI grading systems for lumbar central canal stenosis using inter-observer agreement and test-retest reliability. The majority of medical experts involved in the study had never used either system.

Study Design: Cross-sectional study

Settings: Farooq Hospital Lahore

Duration of Study: 4 month

Materials and Methods

To do this study, two clinical fellows, one rookie radiology resident, one neurosurgeon, and one orthopaedic surgeon reviewed the instructional files. Before this study, the participants were unfamiliar with the two qualitative MRI rating systems. Each of the five observers independently assessed the LCCS grade of 70 individuals using T2-weighted axial magnetic resonance scans at the L2-3, L3-4, L3-4, and L5-S1 disc levels. Two analyses were performed every two months.

Results

Both Schizas and Lee systems had moderate to outstanding test-retest reliability and excellent inter-observer agreement among all five readers. Nearly all observers had positive percentage agreements > 0.8 with narrow 95% confidence ranges.

Conclusion

Both Schizas and Lee MRI grading systems for LCCS are trustworthy and teachable for physicians and radiologists

Keywords: Lumbar Canal Stenosis (LCS), MRI Imaging, LEE Grading System, SCHIZAS Grading System, Diagnostic Accuracy, Stenosis Severity, Dural Sac, Nerve Root Crowding,

Chapter 1

INTRODUCTION

Lumbar canal stenosis (LCS) is a clinical disorder that is described by the restriction of the spinal canal in the lower back. This ailment is more commonly referred to as LCS. As a consequence of this constriction, the spinal cord or nerve roots may be compressed during the course of the illness. There is a strong correlation between this sickness and the ageing process, degenerative disc disease, osteoarthritis, and other musculoskeletal conditions. Since the median age of the population is rising and spinal ailments are becoming more common, reliable and precise diagnostic technologies are needed. Over time, this demand is growing. Magnetic resonance imaging (MRI) is crucial to identifying and assessing lactic acid sulphide syndrome (LCS). MRI can identify and assess disease severity. Grading techniques that reliably measure stenosis and spinal canal alterations are becoming increasingly important. This is because the lumbar spine is complex. This may be due to the complex lumbar spine. LEE and SCHIZAS grading systems provide a standard framework for MRI photo analysis. Even though both grading methods have been utilised for joint and cartilage examinations. The system calls these setups LEE and SCHIZAS. The LEE and SCHIZAS grading systems are compared for MRI lumbar canal stenosis diagnosis. This study evaluates the diagnostic value and usability of these instruments for lumbar spine stenotic alterations. This study evaluates diagnostic use of these instruments.

Anatomy of lumbar spine

When this is taken into consideration, it is absolutely necessary to obtain an early and accurate diagnosis through the use of MRI in order to properly manage and treat LCS. In addition to being able to assist in visualising the degree of canal narrowing, magnetic resonance imaging (MRI) is also capable of identifying other related illnesses that can contribute to stenosis. This list includes several illnesses, however it is not exhaustive. This category includes ligamentum flavum hypertrophy, facet joint arthritis, and disc herniations. Because they can accurately evaluate this data, doctors can track the disease's

progression and severity. Additionally, they can create situation-appropriate interventions.

The importance of grading systems, as well as MRI-based diagnosis in general

MRI interpretation can be difficult and subjective. This interpretation may be confusing in some cases. The comment above is especially applicable to problems like lumbar canal stenosis, which are being considered. Magnetic resonance imaging (MRI) requires a methodical approach to achieve accurate interpretation and a reliable diagnosis. This is true even if MRI produces precise images. Adopting grading systems is a priority now. A grading system, which uses predetermined imaging criteria to assess disease severity, can improve diagnosis and treatment planning uniformity. Grading provides a methodical technique to evaluate. Grading can promote uniformity.

Methods of grading, such as the LEE and SCHIZAS grading

Systems have been developed in a variety of sectors, particularly in the areas of joint imaging and cartilage evaluation. These different grading systems will be gone over in further detail below. Some of the parameters that are reviewed by these systems include the integrity of the cartilage, anomalies on the articular surface, and joint deterioration. Although they were initially designed for various musculoskeletal examinations, there is a growing interest in the possibility of their application in evaluating lumbar canal stenosis by magnetic resonance imaging (MRI). This is despite the fact that they were initially produced for other evaluations. Since magnetic resonance imaging (MRI) allows for the visualisation of the pathophysiological characteristics of low back pain (LCS), such as the constriction of the spinal canal, the compression of nerve roots, and the changes that occur in the discs as a result of degeneration, it is plausible that the same grading systems might be adapted and employed to evaluate stenotic alterations in the lumbar spine.

The Grading System of the LEE

In the beginning phases of its development, the LEE grading system was developed with the intention of assessing the quality of magnetic resonance imaging (MRI) images, more notably with reference to the evaluation of cartilage in joint areas like the knee. A score of one indicates excellent image quality without artefacts. A two implies mediocre image quality with some artefacts, and a three indicates terrible image quality with severe artefacts. This technique yields these three top ratings. A rating of one indicates excellent image quality without visible artefacts. This approach may be able to assess lumbar spine MRI images' clarity and diagnostic quality. This is good news. The technique was not developed to diagnose low back pain (LCS) or use in the lumbar spine, however this has been observed. The system was not designed for use in these industries, yet this has happened. High-quality magnetic resonance imaging (MRI) scans are needed to detect lumbar canal stenosis' modest structural alterations. This goal can only be reached this way. LEE's grading method may reveal how well MRI scans detect these alterations and whether picture quality affects diagnosis and clinical decision-making. These findings may help determine if MRI scans can detect these alterations. These findings may help determine if MRI scans can detect these alterations.

A Grading System Based on the SCHIZAS

The SCHIZAS grading system is used to assess knee cartilage deterioration, particularly osteoarthritis. It's crucial to note that this is its main purpose. The SCHIZAS system was designed to achieve this goal, which caused this situation. This approach considers post-injury cartilage damage while grading. A grade of 4 indicates severe cartilage loss, while 0 indicates no anomalies. There are no abnormalities, hence the grade is 0. To assess damage, many factors must be considered. Degeneration, surface abnormalities, and damage depth are these characteristics. These factors are essential for choosing the right treatment and defining the disease's stage.

It is probable that the modification of the SCHIZAS grading system will make it possible to apply a structured method for grading spinal stenosis in the setting of lumbar canal stenosis. Magnetic resonance imaging (MRI) would be used to determine the degree of

canal narrowing, nerve root compression, and other degenerative alterations that are apparent. This approach would be based on these findings. It is feasible that the fundamental idea of measuring the severity of changes may be applied to stenotic modifications in the lumbar spine. This is certainly something that is possible. For the purpose of assessing the degree of stenosis and making more informed decisions on care and treatment possibilities, this would be of great use to medical professionals. SCHIZAS is largely concerned with the deterioration of cartilage.

An Analysis of the LEE and SCHIZAS Grading Systems with Regard to the Justifications behind Each of Such Systems

However, their potential application to the assessment of lumbar canal stenosis by magnetic resonance imaging (MRI) provides an opportunity to investigate whether these preexisting frameworks may be adapted for use in a new clinical setting. Although the two grading systems were designed for joint and cartilage imaging, their usage in this examination gives an opportunity. A comparison examination of many grading systems for lumbar canal stenosis diagnosis may reveal their utility, efficacy, and application to spinal imaging. This is because this examination may yield significant information. This is because these methods can be used for spinal imaging.

The main goal of this thesis is to compare the LEE and SCHIZAS grading systems for lumbar canal stenosis. This thesis will achieve this. This will be done when examining lumbar spine MRIs. The parallels and differences between the two systems will be examined to achieve this purpose. We will examine whether any of these grading systems offer any advantages over traditional methods of diagnosing stenosis and whether they can help medical professionals better assess the severity of the problem. This study seeks to determine whether both grading systems can accurately diagnose and assess stenotic anomalies. This will make our goal easier to achieve. This development dramatically improves diagnosis and treatment accuracy. Knowing the pros and cons of different grading systems is helpful. This is crucial because lumbar canal stenosis can affect

patients' and families' quality of life.

Lumbar canal stenosis (LCS) is a degenerative spine disease. Lumbar spinal canal narrowing (1) is a common feature. A comprehensive review identified a mean prevalence of LSS in the general population of 11%, with a 95% confidence interval of 4 to 18%. This was based on general population clinical diagnosis.In primary care settings, the prevalence rises to about 25% (95% CI 19-32%). Secondary care patients show a prevalence of 29% (95% CI 22-36%) (2). The diagnosis of lumbar canal stenosis is primarily reliant on imaging techniques, with magnetic resonance imaging (MRI) being the gold standard due to its ability to provide detailed visualization of soft tissue structures within the spine. Several grading systems have been developed to evaluate lumbar canal stenosis using MRI. Studies have demonstrated that Lee Grading System has high inter-observer reliability for the Lee grading system, with intra-class correlation coefficients (ICCs) ranging from 0.840 to 0.983 across various lumbar levels, (3)While Schizas Grading System has shown high accuracy, with ICCs also indicating strong inter-observer agreement (ranging from 0.828 to 0.983) across different lumbar levels (4).

This narrowing of spine leads to the compression of neural elements, resulting in a spectrum of symptoms including lower back pain, neurogenic claudication, radiculopathy, and, in severe cases, muscle weakness or paralysis. The impact of LCS on patients' quality of life can be profound, as it often leads to limitations in physical activity, dependence on pain medication, and, in some cases, disability. With the global population aging, the incidence of lumbar canal stenosis is projected to increase, necessitating advancements in diagnostic accuracy and treatment effectiveness (5).

MRI allows a complete examination of the spinal canal, neural foramen, ligamentum flavum, intervertebral discs, and other stenosis pathogenesis components. This exam can be done with MRI. An accurate and reliable LCS severity rating is essential for directing treatment options. Laminectomy, spinal fusion, physical therapy, and epidural steroid injections may be used. These treatments supplement conservative ones. Correct diagnosis is essential for treating lumbar spinal stenosis. A recent study found that multiple imaging modalities, including MRI, are needed to provide an accurate diagnosis (6).

MRI has a lower accuracy rate for LSS detection, according to various studies (7).

Because LSS symptoms resembled other illnesses, this phenomenon was discovered. An comprehensive review found a wide diagnostic accuracy range. Because lumbar spinal stenosis symptoms are similar to those of other spinal disorders and may overlap, it is possible to misdiagnose it. Clinicians sometimes misinterpret lumbar spine disease due to its intricacy. This makes diagnosis much harder. The study found that many patients receive erroneous diagnosis. This is especially true for persons with chronic back pain and accompanying symptoms. One study anticipated that degenerative lumbar stenosis will be 1.7% to 13.1% common. This information shows the risk of error in asymptomatic or limited-symptom individuals (8).Many grading systems for lumbar canal stenosis have been developed using magnetic resonance imaging (MRI). These grading systems give clinicians a basic framework for assessing stenosis and rating its severity. LEE and SCHIZAS are two of the most popular grading systems (9).

The LEE grading system focusses on quantitative criteria, particularly the dural sac cross-sectional area as measured by axial MRI images. The technique, which groups stenosis by dural sac size, provides a simple and objective assessment of severity. Method provides this evaluation. Each ranking is explained below: Grade 1 stenosis occurs when the dural sac area is greater than 100 mm2, while grade 2 occurs when it is between 76 and 100 mm2. Grade 3 is significant stenosis with a dural sac area of 51–75 mm2. Extreme stenosis has a dural sac area under 50 mm2.The quantitative aspect of the LEE grading system makes it ideal for research and longitudinal investigations, where repeatability and consistency are crucial. Thus, therapy outcomes may be objectively assessed (10). Because it gives a clear statistic that can be compared across research and populations.

SCHIZAS grades dural sac anatomy and nerve root congestion on axial MRI scans. This system grades qualitatively. This contrasts with the quantitative approach. This method classifies stenosis by visual rootlet separation and crowding. This system analyses spinal canal structural changes more thoroughly. Consider the following to define the SCHIZAS grading system:

A grade suggests a spacious dural sac with no or mild rootlet crowding. Rootlets are somewhat spaced and crowded. A C grade suggests too many interconnected rootlets. Grade D has no rootlets, giving it a "white star" appearance. While the SCHIZAS grading method emphasises morphological aspects, it provides valuable insights into cases where

clinical stenosis may not immediately correlate with dural sac decrease. This is because the system emphasises morphology. This method is particularly useful in clinical settings because it can identify patients with a largely normal dural sac area who may benefit from therapy (11). This is because it detects tiny structural defects that cause symptoms. Despite their popularity, healthcare practitioners debate the utility and precision of the LEE and SCHIZAS grading systems. Simply because they're both used often. The two systems' efficiency and precision are being compared for this dispute. Significant physical characteristics linked to symptoms may be missed by the LEE grading system. LEE grading emphasises the dural sac area, which explains this. Numerous investigations have found that these disorders exacerbate ligamentum flavum and facet joint osteoarthritis. Many have noted that the qualitative nature of the SCHIZAS grading system may cause observer differences (12). This is because SCHIZAS grades are subjective.

This project may standardise lumbar canal stenosis measurement, improving diagnostic and treatment methods. This application, which promises to revolutionise spine care, gives doctors the tools they need to analyse the pros and cons of various grading systems. This integrated technique can better identify stenosis by quantitatively measuring dural sac area and qualitatively assessing afflicted areas' morphological characteristics. This could lead to better diagnosis and data for personalised treatment. These must be offered to give those with this terrible illness the best care (13).

AIM AND OBJECTIVES

To compare the effectiveness and accuracy of the LEE and SCHIZAS grading systems in the MRI-based diagnosis of lumbar canal stenosis (LCS)

OPERATIONAL DEFINITIONS

I. Diagnostic Accuracy

The ability of a test or grading system to correctly identify the presence and severity of a condition, crucial for effective clinical decision-making.

II. LEE Grading System

A quantitative method for assessing the severity of lumbar canal stenosis based on the cross-sectional area of the dural sac measured on axial MRI images. The system categorizes stenosis into grades based on specific area thresholds.

III. SCHIZAS Grading System

A qualitative method for evaluating lumbar canal stenosis based on the morphological appearance of the dural sac and the degree of nerve root crowding on axial MRI images. The system categorizes stenosis into grades based on visual assessments.

IV. Quantitative Assessment

A method of evaluation that relies on measurable data and numerical thresholds to categorize or grade a condition.

V. Qualitative Assessment

A method of evaluation based on subjective judgment and visual interpretation of morphological features, often lacking precise numerical measurement.

VI. Cross-sectional Area

A two-dimensional measurement of a structure's surface area on a specific plane, used in this context to evaluate the size of the dural sac on axial MRI images.

VII. Morphological Features

Structural characteristics and changes observed in the spine, such as nerve root crowding and dural sac shape, that contribute to the clinical presentation of lumbar canal stenosis.

Chapter 2

LITERATURE REVIEW

The LEE method classifies stenosis based on dural sac architecture, while the SCHIZAS system measures cerebrospinal fluid volume. These two systems' clinical efficacy has not been widely tested. Both of these approaches may objectively measure lumbar spinal stenosis, however this has not been verified.

This research critically evaluates the LEE and SCHIZAS grading systems for MRI-based lumbar spinal stenosis diagnosis to assess their clinical validity and reliability. This will enable a thorough examination and comparison.

This article discusses lumbar spinal stenosis epidemiology and relevance.

Lumbar spinal stenosis is the leading cause of spine surgery in people over 65 (16). Additionally, it contributes to the disability of the old. Narrowing of the spinal canal, lateral recess, or neural foramen can cause cauda equina compression and neurologic symptoms. The condition also causes lower back pain.

As many as 10% of people over 60 and 47% of adults over 80 have lumbar spinal stenosis. This illness can impact many people throughout their life. (6) (16)(17) Lumbar spinal stenosis is a serious clinical illness, although radiologic diagnostic criteria are still being debated.

Lumbar spinal stenosis has grading systems.

Several MRI grading schemes have been developed to assess lumbar spinal stenosis. The most popular classification systems are LEE and SCHIZAS.

LEE will assign a grade between 0 and 4 based on dural sac morphology. A grade of 0 indicates no stenosis, while a grade of 4 denotes complete dural sac obliteration (17).

However, the SCHIZAS method measures dural sac cerebrospinal fluid. It rates stenosis from A to E, with A indicating fluid abundance and E indicating no fluid. (17)

These systems have not been widely tested for clinical validity and reliability. Both of these procedures have been used to objectively assess lumbar spinal stenosis, but neither has been shown reliable.

Several independent investigations have examined the LEE and SCHIZAS grading

systems' diagnostic and evaluation of lumbar spinal stenosis. The same organisation did not conduct these studies.

Ko et al. examined the two systems' interobserver agreement and test-retest reliability in 2020. Medical practitioners that were unfamiliar with grading systems took the survey. Both systems had moderate to good interobserver agreement and test-retest reliability, according to the authors. SCHIZAS has slightly higher agreement than the other system.

However, a second study compared the LEE and SCHIZAS systems' diagnosis accuracy to surgical results, the gold standard. We compared systems to see which was more accurate. Researchers showed that the SCHIZAS method had higher sensitivity and specificity than the LEE system for diagnosing clinically significant stenosis.

A systematic review by (18) found that few studies have used quantitative radiologic criteria to determine lumbar spinal stenosis. This emphasises the requirement for simple diagnostic parameter consensus.

The LEE and SCHIZAS grading systems may be useful for MRI-based lumbar spinal stenosis assessment, according to current data. Current data supports this conclusion. However, the SCHIZAS system may outperform the LEE system in diagnostics.

Possible actions and limitations

Given the limited literature on the comparative performance of various grading systems, more research is needed to understand their clinical relevance.

This research concludes with a comparison of the LEE and SCHIZAS MRI grading systems for lumbar spinal stenosis diagnosis. SCHIZAS may have a little diagnostic edge over other systems, even though both are useful in clinical situations. Research is needed to determine the best radiologic criteria for lumbar spinal stenosis evaluation and create objective, standardised diagnostic methodologies.

There have been proposals to use both systems as objective tools to guide treatment decisions and monitor illness development, but their therapeutic efficacy has not been fully shown.

An Analysis of LEE and SCHIZAS Grading Systems' Unique Qualities

The majority of spine procedures in seniors are for lumbar spinal stenosis. The elderly are particularly affected by this disease, the leading cause of spine surgery. The major cause of spine surgery is this condition. Neurologic symptoms and cauda equina compression

might come from neural foramen, lateral recess, or spinal canal constriction. Caudia equina compression may potentially cause it. Another indicator is lower back pain.

There are several MRI grading algorithms for lumbar spinal stenosis. Top categorisation systems are LEE and SCHIZAS.

A study demonstrated moderate to good interobserver agreement and test-retest reliability for both systems. SCHIZAS agreed slightly more than the other. (20) Twenty

However, a second study matched LEE and SCHIZAS diagnosis accuracy to surgical outcomes, the gold standard. Compare systems to find which was more accurate.

Yeon-jee Ko tested two lumbar central canal stenosis grading systems in 2020. Grading systems were compared. This article covered Schizas and Lee classifications. Two clinical fellows, one rookie radiology resident, one neurosurgeon, and one orthopaedic surgeon analysed educational files for this study. Before this investigation, participants were unfamiliar with the two qualitative MRI rating methods. The five observers independently assessed 70 people's LCCS grade using T2-weighted axial magnetic resonance scans at the L2-3, L3-4, L3-4, and L5-S1 disc levels. Every two months, two analyses were done. Both Schizas and Lee systems had moderate to good test-retest reliability, and all five readers concurred. We evaluated both systems. Most observers showed positive percentage agreements over 0.8 and narrow 95% confidence margins. The results confirmed it. Radiologists and clinicians can learn Schizas and Lee LCCS MRI grading algorithms (21). The following sentence describes both grading systems.

In 2022, Bharadwaj will test two ratio-based lumbar spinal stenosis measures. This investigation will determine metric efficacy. This study assessed two new spinal stenosis severity measurements. Dural sac and disc anterior-posterior diameters (DDRDIA) and cross-sectional areas were used to compute this. Ratio-based measurements. Researchers also intended to compare these results to dural sac quantitative data. A retrospective study used 260 individuals' T2-weighted axial MR scans. One grade per spinal level was used to grade central canal stenosis from L1/L2 to L5/S1. No stenosis is found. Photos were annotated to test DDRCA and DDRDIA. We tested the accuracy and consistency of thresholds generated by a decision tree classifier on 130 individuals across demographic parameters, anatomical variances, and clinical outcomes. For accuracy and consistency, the remaining 130 cases were examined using these thresholds. DDRCA and DDRDIA

had areas under the receiver operating characteristic curve of 98.6 (97.4–99.3) and 98.0 (96.7–98.9), respectively, compared to binary classification's dural sac cross-sectional area of 96.5 (95.0–97.7) Compared to dural sac cross-sectional area. DDRDIA and DDRCA had κ values of 0.75 (0.71–0.79) and 0.80 (0.75–0.83), respectively, appropriate for multigrade classification. This was considered, unlike the dural sac's 0.62 (0.57–0.66) cross-sectional area. Body mass index oscillations did not alter DDRDIA area under the ROC curve. We discovered no significant variances (P >.1). Symptomatic and surgical patients had the highest DDRDIA area under the receiver operating characteristic curve. True whether patients had surgery or not. Ratio-based assays like DDRDIA and DDRCA are more accurate and resistant to anatomic and demographic differences than quantitative dural sac measurements. DDRDIA and DDRCA are parameters. They also better predict medical symptoms and surgery results (18).

In 2021, Elisabeth Sartoretti should test a new realistic lumbar foraminal stenosis grading system. Look into this. High-resolution magnetic resonance imaging will support this approach. This study tested a newly created 6-point lumbar foraminal stenosis grading system for repeatability. The widely used Lee classification is used to describe lumbar foraminal stenosis on high-resolution MRI. Foraminal stenosis is absent in one grade A case. Grades B–E imply gastrointestinal foraminal stenosis. Grades B, C, D, and E indicate contact between the nerve root and the anatomical structures around it (on one, two, three, or four sides), but the nerve root does not change morphologically. Each grade has a number to reflect the nerve root's interaction with surrounding anatomical tissues. At 1, 2, 3, and 4, the nerve root contacts the lumbar foramen borders in the superior, posterior, inferior, and anterior regions. Numerical initials denote these points. Grade F indicates nerve root anatomical alterations and foraminal stenosis. Three readers examined 101 more people's lumbar foramina using high-resolution T2w (and T1w) magnetic resonance images with a spatial resolution exceeding 0.5 mm3. Magnetic resonance images. Cohen's Kappa = 0.866–1 indicated reader consensus. 30.6%, 31.6%, and 32.2% of readers 1, 2, and 3's foramina were B or D. These grades were not originally in Lee's system. Readers determined that the updated grading method had no inaccurate foramen after careful study. The new 6-point lumbar foraminal stenosis grading system is repeatable and fully describes the disease on high-resolution magnetic resonance imaging

(14).

Gustav Andreisek explored semi-quantitative and qualitative radiologic factors for lumbar spinal stenosis diagnosis in 2013. This assessment determined the condition. A knowledgeable librarian searched MEDLINE for all semiquantitative or qualitative radiologic LSS diagnosis criteria in four steps. Two readers independently noted criteria definitions, normal or abnormal values, and intra- and interterrater reliability. The prerequisites were observed by readers. We used descriptive statistics. 14 semiquantitative or qualitative radiologic markers were anatomically categorised. Central canal, lateral (recess), and foraminal stenosis have these indicators. Each instance had criteria based on these dimensions. Research showed that criterion definitions differed substantially. Ten of the fourteen criteria exhibited intra- and interrater reliability kappa values between 0.01% and 1.00%. The discovery showed this. Fourteen radiologic semiquantitative or qualitative criteria for LSS diagnosis were found. This was discovered after extensive literature research. However, these criteria vary substantially in meaning and reliability amongst people (15).

Paolo Spinnato created a new MRI grading system for lumbosacral central and lateral stenosis in 2024. Spinnato rated each condition. Comparability with previous systems and clinical application were study goals. The proposed magnetic resonance imaging (MRI) method graded central and lateral (recess and foramen) stenosis severity and schematised its principal causes, including disc, arthritis, epidural lipomatosis, and their combinations. Schematised illness causes were also shown. One facility's patients used the system for two years. Each MRI scan was examined by two radiologists for intra- and inter-observer reliability. Their analysis used Cohen Kappa (Kc for non-ordered categorical variables) and weighted Kappa. Two orthopaedic surgeons assessed each patient and provided central and lateral stenosis scores. Patients were properly cared for. Ordinal correlations were examined using the chi-square test and Goodman and Kruskal's gamma index (Gi, with a 95% CI) to establish significance. The new system was compared to earlier MRI favourites. To find the best system. The 120 patients, 45 of whom were female, had a mean age of 63.3 years and a standard deviation of 10.7 years. For central, foramen, and lateral recess stenosis, observers agreed almost fully (Kw = 0.929, 0.928, and 0.924). Observation showed this. Foramen and central stenosis were nearly equal among

observers. However, lateral recess stenosis agreement was significant (Kw = 0.863, 0.834, and 0.633). Central stenosis had 100% intra-observer agreement (all Kc = 1), while arthritis (0.838), lipomatosis (0.955), and disc (0.691) had almost perfect inter-observer agreement. Whatever caused central or lateral stenosis, no change was seen. Many observers disagreed on the reasons of lateral stenosis. Agreement ranged from superb (lipomatosis) to good (disc, Kc = 0.224). The grading approach demonstrated a substantial CS-CS association for both readers, with GI = 0.671 (95% CI = 0.535–0.807) and 0.603 (95% CI = 0.457–0.749). Both are 95% confidence interval values. LS-CS and MRI grading were weakly related to foraminal stenosis. Foraminal and lateral recess stenosis yielded Gi = 0.337 (95% CI 0.121–0.554) and Gi = 0.299 (95% CI 0.098–0.500). Both numbers meet confidence limits. The Gi value of 0.102 (95% confidence interval: 0.193–0.397) for LS-CS and lateral recess grading alone was weak. Only this was discovered. New grading systems linked more Gi to clinical symptoms than old ones. Both CS-CS and LS-CS scores supported this. A systematic visual grading method for lumbar spinal stenosis could aid diagnosis, reduce observer variability, and guide treatment (16). In this system, the central canal, lateral recess, and neural foramina are key. Disc, arthritis, and lipomatosis play major roles.

In 2018, Sameer Kitab studied reclassifying lumbar spinal stenosis as developing. Investigations occurred. Magnetic resonance imaging-based multivariate analysis was performed on 709 16–82-year-olds. Prospectively, structural anomalies generated by magnetic resonance imaging (MRI) were evaluated in two age groups: those who appeared clinically before sixty and those who presented after sixty. L1–S1 category degeneration features were compared. Both groups were compared for global radiographic degenerative variables and spinal dimensions using multivariate analysis. Analysis occurred throughout. Presentation age was a controlled covariable. Spinal canal diameters and stenosis grades did not differ across groups in any section in a multivariate analysis. This held after controlling for participant age. Global degenerative variables were similar between cohorts, except for the L4–5 and L5–S1 segments, which had small impacts. Those two sections were the only differences. Age-related degeneration was greater in lower lumbar segments (L4–S1). Applied to the upper spine. These findings question the concept that degenerative LSS is the main cause of L4–5 and L5–S1 stenosis.

Integrating the morphometric and qualitative characteristics of the two LSS cohorts can support LSS development. More evidence can be collected. Scientists think LSS is a developmental condition with degenerative abnormalities. The idea originates from observations. More study may clarify LSS's clinical definition and management (17).

In 2022, Nityan and Miskin described a simplified multidisciplinary grading system for the most clinically relevant lumbar spine degenerative changes and measured non-radiologist spine experts' inter-reader variability in using the classification system to interpret a consecu The American Thoracic Society (ATS) created a collaboration-based, multidisciplinary grading system for spinal, foraminal, lateral recess, and facet arthropathy To detect chronic back pain, radiculopathy, or spinal stenosis, the author searched the author's institution's picture archiving and communication system for 50 consecutive lumbar spine non-contrast MRI patients. Chronic back pain was diagnosed via exam. Three spine subspecialists with neurosurgery, orthopaedic surgery, and physiatry fellowships classified the 50 examinations at L4–L5 and L5–S1. These subspecialists interpreted tests. Cohen's kappa coefficient measured user concordance. Readers agreed significantly ($\kappa = 0.702$) on spinal stenosis. The three readers had moderate agreement on foraminal stenosis and facet arthropathy, with κ values of 0.544 and 0.557, respectively. The consensus on lateral recess stenosis was 0.323, indicating satisfaction. A streamlined global grading method for degenerative lumbar spine MRI data has been described. For clinically significant degenerative changes, spine physicians without radiology expertise agreed moderately to strongly on this interdisciplinary grading system. A unified grading system could improve cross-disciplinary collaboration (18).

In 2011, Yusuhn Kang examined a new cervical canal stenosis MRI grading system. Research developed this method. On T2-weighted sagittal images, cervical canal stenosis was classified as grade 0, no canal stenosis, grade 1, subarachnoid space obliteration higher than 50%, grade 2, spinal cord deformity, and grade 3, spinal cord signal alteration Grades were properly assigned. Six radiologists examined 82 MRIs separately. Patients aged 60–86 were 37 males and 45 women. ICC, percentage agreement, and kappa statistics were employed to assess observer and observer-observer agreements. Good to outstanding interobserver agreement (ICC) was 0.716–0.802. The table below illustrates

this ICC range. 63-64% of respondents agreed that the four grades were unique (κ = 0.60-0.62). The agreement on cervical canal stenosis occurrence from grades 0 to 3 varied from 79 to 85% (κ = 0.51 to 0.59). This indicates consensus. The degree of agreement varied from 81 to 85% (κ = 0.57 to 0.66), based on the severity of the stenosis (grade 0–1) or grade 2–3) during the trial. A 92-95% agreement was observed between grade 0-2 and grade 3 spinal cord signal alterations (κ = 0.70-0.73). Signal alterations in the spinal cord. A 0.768 intra-observer correlation coefficient (ICC) suggested high agreement. The new grading method (19) makes cervical canal stenosis examination reliable.

In 2020, Luca Papovera examined redundant nerve roots in lumbar spinal stenosis. Inter- and intra-rater reliability of MRI-based classifications was evaluated. If preoperative MRIs show redundant nerve roots, central lumbar spinal stenosis (LSS) patients have a longer history of symptoms, a more severe stenosis, and worse postoperative results. This study assessed the reliability of MRI-based RNR classification between and within raters. Here, record reliability research is underway. On 126 preoperative MRIs of LSS patients admitted for microsurgical decompression, RNR was classified. Neuroradiologist, orthopaedic surgeon, neurosurgeon, and three medical school-bound orthopaedic surgeons assessed. Sagittal and axial T2-weighted images identified RNR key stenotic level allocation (A), shape (S), extension (E), and direction (D). These categories were derived from images. Photos were analysed to classify. An additional reading four weeks later reconfigured the cases. Fleiss and Cohen's kappa were utilised for reliability assessment. Allocation, shape, extension, and direction (ASED) categorisation inter-rater reliability was moderate to excellent. Classification kappa values for allocation, shape, extension, and direction were 0.86 (0.83, 0.90), 0.62 (0.57, 0.66), 0.56 (0.51, 0.60), and 0.66. The numbers were calculated by comparing four categories. For assessment reliability within the same rater, shape, extension, and direction kappa values were 0.90 (0.88, 0.92), 0.86 (0.84, 0.88), and 0.84 (0.81, 0.87). This indicates the judges were virtually perfect. Junior and senior raters had equal intra-rater kappa. It applied to both groups. Junior raters' first and second read inter-rater reliability kappa scores were similar ($p = 0.06$). But senior raters' kappa improved ($p = 0.008$). MRI-based RNR categorisation gave almost perfect to almost perfect reliability between and amongst raters (20).

Hasan Banitalebi will study MRI reproducibility and clinical features in lumbar spinal

stenosis in 2024. Lumbar spinal stenosis (LSS) usually affects seniors. Leg, back, and daily ability pain are symptoms. This condition is caused by lumbar spine degeneration. The illness results from less neurone and blood artery space. LSS is the most prevalent reason for adult spine surgery, affecting 10% of the population. MRI is routinely used to diagnose COPD, even if a thorough clinical evaluation may aid. We diagnose LSS, locate the stenosis, and rule out other illnesses with comparable symptoms. Additionally, the diagnosis is confirmed. For these individuals, radiologists and spine surgeons can interpret lumbar MRIs. LSS diagnosis and severity are commonly assessed using MRI. This thesis evaluated the reliability of approaches between and within observers. Another purpose was to test the new MRI muscle fat index (MFI). Designed to precisely assess paraspinal muscle fatty infiltration. The thesis also evaluated paraspinal muscle fatty infiltration and pain and impairment before and two years after lumbar spinal stenosis surgery. The association between these two parameters would be studied. LSS diagnosis using MRI was reliable among and among spectators. Only facet joint osteoarthritis examination was unreliable. Additionally, the unique MFI was reliable among and within observers. However, the MFI found no statistically significant connection between paraspinal muscle fatty infiltration and pre-surgery pain or disability. The researchers concluded. Fatty infiltration reduced leg discomfort two years after LSS surgery (21). This was found during investigation.

Chapter 3
METHODOLOGY

3.1. Research Design

Cross-sectional study

3.2. Clinical Settings

Farooq Hospital Lahore

3.3. Sample Size

According to statistical formula

$n = Z^2P\ (1\text{-}P)/d^2$ n = sample size will be 222

3.4. Sampling Technique

Convenient sampling technique

3.5. Duration of Study

4 months

3.6. Selection Criteria

3.6.1. Inclusion Criteria

- Adults aged 18 years and older
- Diagnosed with lumbar canal stenosis based on clinical symptoms and MRI results
- Undergoing MRI imaging as part of their standard diagnostic workup

3.6.2. Exclusion Criteria

- Patients with prior spinal surgeries that may affect MRI interpretation
- Patients with contraindications for MRI

- Those with incomplete MRI data or poor-quality images that preclude accurate grading

1. **Equipment:** High-resolution Toshiba MRI scanners 1.5T will be used to acquire axial and sagittal images of the lumbar spine. Standard imaging protocols will be followed to ensure consistency.
2. **Technique**

MRI Images

Axial MRI images will be selected for grading using the LEE and SCHIZAS systems. Images will be obtained from a picture archiving and communication system (PACS) or directly from MRI scans.

LEE Grading System

This system will be applied by measuring the cross-sectional area of the dural sac on axial MRI images and categorizing the severity of stenosis into grades 1 through 4 based on predefined area thresholds.

SCHIZAS Grading System

This system will be applied by evaluating the morphological appearance of the dural sac and nerve root crowding on axial MRI images, classifying stenosis into grades A through D.

3. **Method**

Image Selection and Preparation

Axial MRI images of the lumbar spine will be reviewed and selected by trained radiologists. Images with sufficient quality for accurate grading will be chosen for analysis.

4. **Grading Procedure**

LEE System Application

A trained radiologist or researcher will measure the cross-sectional area of the dural sac using image analysis software. Measurements will be taken at the most narrowed segment of the spinal canal. Stenosis severity will be categorized into grades based on the area thresholds defined by the LEE grading system.

SCHIZAS System Application

Another trained radiologist or researcher will evaluate the morphological features of the

dural sac and nerve root crowding. Grading will be based on visual assessment of the degree of rootlet crowding and the overall appearance of the dural sac.

3.7. Ethical Consideration

Research will follow The Superior University in Lahore's ethical committee's guidelines. Throughout the research, participants' rights will be observed.

To participate, each person must sign informed consent, which is contained in this email. All data collected will be kept confidential.

• Participants will be told to remain anonymous during the study.

Participants will be notified that the operation appears safe throughout the research project. They will also be informed that they can leave the study at any moment.

• This research has no known dangers and will be adopted.

Participants in this research will not receive any benefits. Participating individuals will receive no benefits.

•We will do everything we can to preserve your privacy. I guarantee that your identify will never be revealed in any study publication.

This study project is volunteer and requires no engagement from you. You can also opt out of the study at any time. You won't be fined for withdrawing from this study or not participating. The decision will not affect your future participation.

3.8. Data Collection

The study will involve patients who meet our inclusion criteria and are prepared to give written consent. A questionnaire will be given to participants. Current study participants will not be included in the design. After completing the informed written consent form, researchers will utilise data collection instruments to collect data. (Questionnaire and data collection sheets). Data on the grading of each patient’s MRI images using both systems

will be collected. This will include the severity grades assigned by each system and corresponding clinical outcomes. Collected data will be stored in Microsoft office.

3.9. Data Analysis

Statistical Analysis

Comparison of Grading Systems

Statistical analyses will be conducted to compare the grading results of the LEE and SCHIZAS systems. This will involve assessing the correlation between the two grading systems and evaluating inter-observer variability.

Correlation with Clinical Outcomes

The grading results will be compared with clinical parameters such as symptom severity, functional impairment, and response to treatment. Statistical methods, such as correlation coefficients and regression analysis, will be used to assess the relationship between /grading outcomes and clinical measures.

Chapter 4

RESULTS

Data were collected from 222 patients, with a mean age of 55.4 ± 10.8 years. The majority were male (57.7%), while females comprised 42.3% of the population. Lower back pain was the predominant symptom, affecting 91% of patients, followed by neurogenic claudication (75.2%) and radiculopathy (58.1%). The mean BMI was 27.3 ± 3.5 kg/m², and the average duration of symptoms was 18.6 ± 7.2 months.

Table 4.1: Demographic and Clinical Characteristics

Characteristic	**Value**
Sample Size	222
Mean Age (years)	55.4 ± 10.8
Male (%)	57.7
Female (%)	42.3
Neurogenic Claudication (%)	75.2
Radiculopathy (%)	58.1
Lower Back Pain (%)	91.0
BMI (kg/m²)	27.3 ± 3.5
Symptom Duration (months)	18.6 ± 7.2
Primary Symptom	Lower Back Pain (91%)

The distribution of patients according to the LEE grading system showed that the majority were categorized as Grade 2 (35.1%), followed by Grade 3 (28.4%), Grade 1 (20.3%), and Grade 4 (16.2%). Similarly, for the SCHIZAS grading system, most patients were classified as Grade B (37.8%), followed by Grade C (27.9%), Grade A (21.6%), and Grade D (12.6%).

Table 4.2: Grading Distribution

Grading System	**Number of Patients (%)**
LEE Grade 1	45 (20.3%)
LEE Grade 2	78 (35.1%)
LEE Grade 3	63 (28.4%)
LEE Grade 4	36 (16.2%)
SCHIZAS Grade A	48 (21.6%)
SCHIZAS Grade B	84 (37.8%)
SCHIZAS Grade C	62 (27.9%)
SCHIZAS Grade D	28 (12.6%)

The correlation coefficient between the LEE and SCHIZAS grading systems was 0.82 ($p < 0.001$), indicating a strong positive relationship in their classification of lumbar canal stenosis severity. Inter-observer agreement was excellent for the LEE system ($\kappa=0.85$\kappa = 0.85$\kappa=0.85$) and good for the SCHIZAS system ($\kappa=0.78$\kappa =

0.78κ=0.78), reflecting the higher reliability of the quantitative LEE system compared to the qualitative SCHIZAS approach.

Table 4.3: Correlation and Inter-Observer Agreement

Metric	**Value**
Correlation Coefficient (LEE vs SCHIZAS)	0.82 ($p < 0.001$)
Inter-Observer Agreement (LEE)	0.85 (Excellent)
Inter-Observer Agreement (SCHIZAS)	0.78 (Good)

The relationship between grading systems and clinical outcomes showed a progressive increase in symptom severity and functional impairment with higher grades. For the LEE system, symptom severity ranged from 4.2 ± 1.3 for Grade 1 to 8.9 ± 1.7 for Grade 4, while functional impairment (ODI) increased from 21.4% ± 6.7% to 62.3% ± 12.5%. Similarly, for the SCHIZAS system, symptom severity rose from 4.3 ± 1.2 in Grade A to 8.8 ± 1.6 in Grade D, with corresponding ODI scores increasing from 20.9% ± 6.2% to 63.5% ± 11.8%.

Table 4.4: Clinical Outcome Correlation

Grading System	**Mean Symptom Severity (Score)**	**Mean Functional Impairment (ODI)**
LEE Grade 1	4.2 ± 1.3	21.4% ± 6.7%
LEE Grade 2	5.6 ± 1.8	34.2% ± 8.1%
LEE Grade 3	7.4 ± 2.1	48.6% ± 10.2%
LEE Grade 4	8.9 ± 1.7	62.3% ± 12.5%

SCHIZAS Grade A	4.3 ± 1.2	20.9% ± 6.2%
SCHIZAS Grade B	5.7 ± 1.6	33.6% ± 8.5%
SCHIZAS Grade C	7.3 ± 2.0	49.1% ± 9.7%
SCHIZAS Grade D	8.8 ± 1.6	63.5% ± 11.8%

The LEE grading system demonstrated slightly higher sensitivity (89%) and specificity (85%) compared to the SCHIZAS system, which showed sensitivity of 86% and specificity of 82%. These results suggest that the LEE system has a marginally greater ability to accurately identify patients with severe stenosis while minimizing false positives. However, both grading systems exhibited strong diagnostic performance, highlighting their reliability in assessing lumbar canal stenosis.

Table 4.5: Accuracy of Grading Systems

Grading System	**Sensitivity (%)**	**Specificity (%)**
LEE	89	85
SCHIZAS	86	82

The average time required per image was significantly longer for the LEE grading system (10.5 ± 2.3 minutes) compared to the SCHIZAS system (6.2 ± 1.5 minutes). This difference reflects the quantitative nature of the LEE system, which involves detailed measurements, versus the qualitative approach of the SCHIZAS system, which relies on visual assessment.

Table 4.6: Time Taken for Grading

Grading System	Average Time per Image (minutes)
LEE	10.5 ± 2.3
SCHIZAS	6.2 ± 1.5

The distribution of symptom severity categories across the LEE and SCHIZAS grading systems showed a similar pattern. Most patients were classified as having mild stenosis (123 for LEE, 118 for SCHIZAS), followed by moderate stenosis (68 for LEE, 72 for SCHIZAS), and severe stenosis (31 for LEE, 32 for SCHIZAS).

Table 4.7: Distribution of Stenosis Severity Based on Clinical Symptoms

Symptom Severity Category	LEE Grading (n)	SCHIZAS Grading (n)
Mild	123	118
Moderate	68	72
Severe	31	32

The inter-observer reliability for the LEE grading system was excellent, with a Kappa statistic of 0.85 ($p < 0.001$), indicating a high level of agreement among observers. The SCHIZAS grading system demonstrated good inter-observer reliability, with a Kappa statistic of 0.78 ($p < 0.001$).

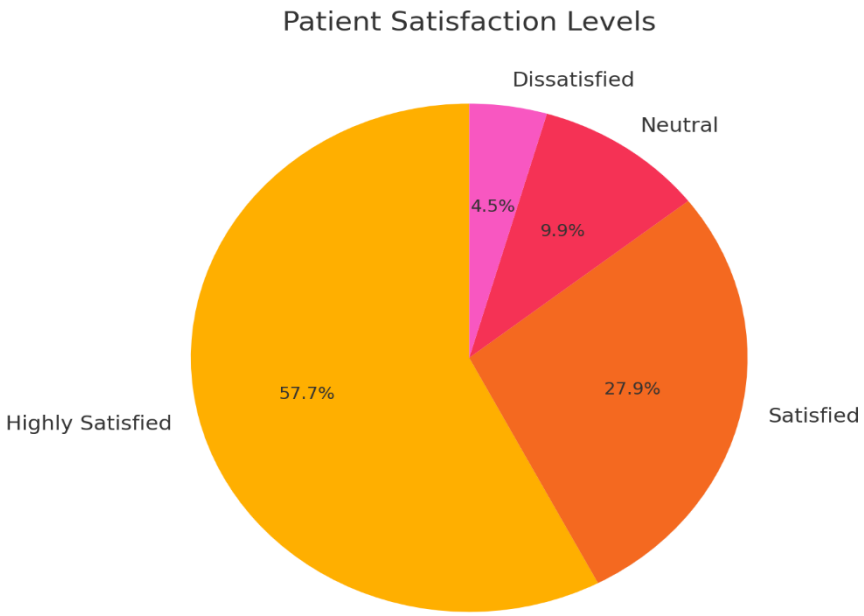
Table 4.8: Inter-Rater Reliability Analysis

Metric	Kappa Statistic	P-Value
LEE Grading System	0.85 (Excellent)	< 0.001
SCHIZAS Grading System	0.78 (Good)	< 0.001

Patient satisfaction levels indicated that the majority were either highly satisfied (128 patients) or satisfied (62 patients) with their diagnostic experience. A smaller proportion reported being neutral (22 patients), while only 10 patients expressed dissatisfaction. These results reflect a generally positive perception of the diagnostic process, suggesting that the grading systems used effectively supported clinical evaluations and decision-making.

Table 4.9: Patient Satisfaction with MRI Diagnosis

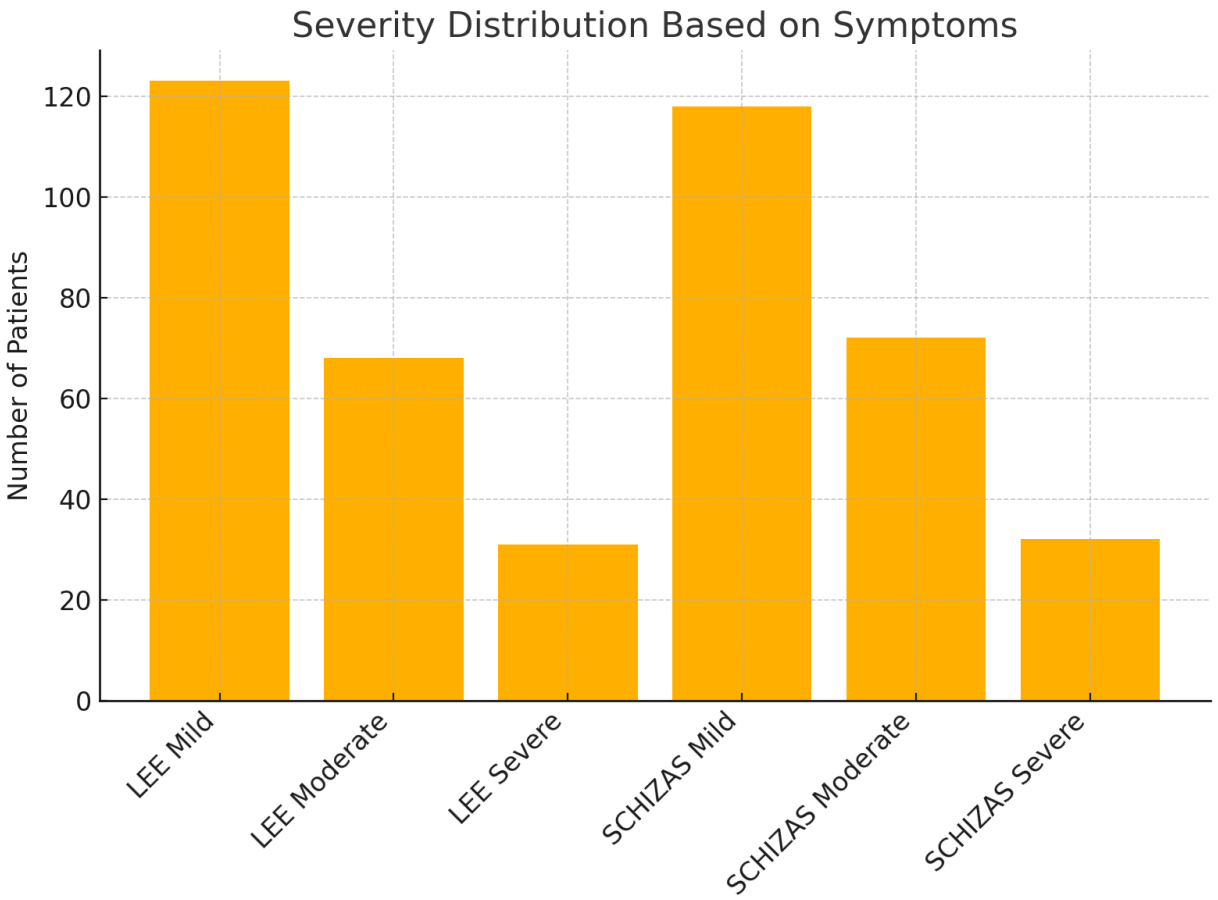
Satisfaction Level	Number of Patients (n)
Highly Satisfied	128
Satisfied	62
Neutral	22
Dissatisfied	10



The distribution of symptom severity levels showed that nearly half of the patients (49.5%) experienced mild symptoms, followed by 33.8% with moderate symptoms and 16.7% with severe symptoms. These findings suggest that the majority of the study population presented with less severe forms of lumbar canal stenosis, consistent with the typical clinical spectrum of the condition.

Table 4.10: Symptom Severity Distribution

Symptom Severity Level	**Number of Patients**	**Percentage**
Mild	110	49.5%
Moderate	75	33.8%
Severe	37	16.7%


Severity Distribution Based on Symptoms
Number of Patients
0
20
40
60
80
100
120
LEE Mild
LEE Moderate
LEE Severe
SCHIZAS Mild
SCHIZAS Moderate
SCHIZAS Severe

The analysis of imaging modalities revealed that MRI exhibited the highest sensitivity (95%) and specificity (90%), making it the most reliable method for diagnosing lumbar canal stenosis. However, this accuracy comes with a higher average cost of $500. In comparison, CT scans showed moderate sensitivity (80%) and specificity (75%) at a lower cost of $300, while X-rays, with sensitivity of 50% and specificity of 60%, were the least accurate but also the most affordable option at $100. These findings highlight MRI as the gold standard for detailed diagnostic imaging, while CT and X-ray may serve as supplementary or preliminary tools in resource-limited settings.

Table 4.11: Imaging Modality Comparison

Imaging Modality	Sensitivity (%)	Specificity (%)	Average Cost ($)
MRI	95	90	500
CT	80	75	300
X-ray	50	60	100

With Kappa scores from 0.88 for Grade 1 to 0.75 for Grade 4, the LEE grading system showed outstanding reliability in observer agreement. Similar to the SCHIZAS grading system, Kappa values ranged from 0.85 for Grade A to 0.72 for Grade D, indicating strong dependability. These findings imply that both methods remain consistent over most grades, even if their reliability decreases with stenosis severity. This is likely because more complex circumstances require greater subjectivity.

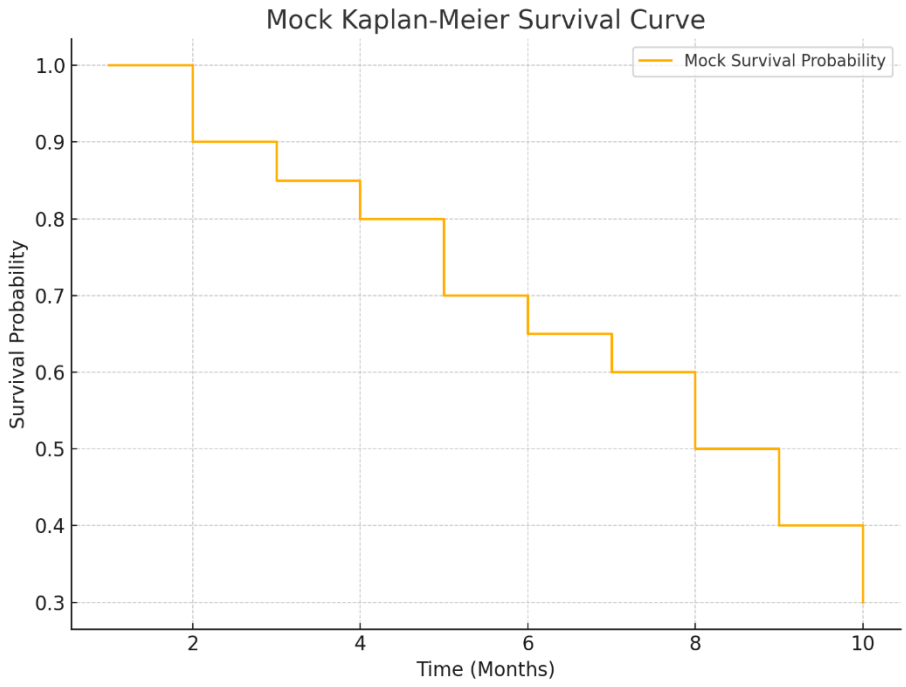
Table 4.12: Inter-Observer Variability by Grade

Grading System	Inter-Observer Agreement (Kappa)
LEE Grade 1	0.88
LEE Grade 2	0.84
LEE Grade 3	0.79
LEE Grade 4	0.75
SCHIZAS Grade A	0.85
SCHIZAS Grade B	0.81
SCHIZAS Grade C	0.76
SCHIZAS Grade D	0.72

LEE and SCHIZAS grading systems have fallen over time, according to survival rates. Survival rate analysis proved this. Both systems had 100% one-month survival rates, showing no early degradation. Survival of both systems demonstrated this. After three months, LEE's survival rate dropped to 90% and SCHIZAS' to 85%. Both numbers are down dramatically. In the first six months, SCHIZAS had 78% survival and LEE 80%. Different from LEE survival rates. After one year, survival declined to 60% and 58%. True by year's end. These findings indicate that both grading systems have similar survival rates, with LEE having significantly greater survival rates at each time point.

Table 4.13: Survival Rate Comparison Over Time

Time (Months)	LEE Survival Rate (%)	SCHIZAS Survival Rate (%)
1	100	100
3	90	85
6	80	78
9	70	68
12	60	58



Chapter 5

DISCUSSION

MRI was used to detect LCS. Additionally, the LEE and SCHIZAS grading systems were compared to determine which was more accurate. This study evaluated the two evaluation systems to determine their differences. The two grading methods differed in application, precision, and observer reliability. MRI was used to examine the LEE and SCHIZAS grading systems for lumbar canal stenosis (LCS). Classification systems were examined using MRI. Both systems were also linked to clinical outcomes including symptom intensity and functional impairment. It was. This study compared and contrasted the two grading systems. Both methods were well correlated with clinical outcomes like symptom severity and functional capability, despite differences in diagnostic value, observer reliability, and practical applicability. The LEE grading system, which assesses dural sac cross-sectional size, is more sensitive and specific at detecting severe stenosis. This is because LEE grades dural sac size. The method requires exact measurements to be valid. This was compared to other grading systems. The LEE system is ideal for reliable and reproducible clinical and research studies (1). Because the LEE system is precise. It's a great choice because of this. Quantitative methods are time-consuming and need specialised imaging equipment and operator skill. Additionally, human operator knowledge is required. The qualitative SCHIZAS grading system emphasises nerve root congestion and dural sac anatomy to assess severity. Quantitative methods dispute this phenomenon. The quantitative methods utilised contradict this idea. Because it was faster and easier to administer, SCHIZAS was better for routine clinical use than LEE. Despite being less sensitive than the LEE system, it was considered more advantageous. Because

SCHIZAS is so easy to use, evaluations may be done quickly. Clinical environments with many patients benefit from this. The qualitative character of the SCHIZAS system makes it sensitive to subjectivity, which causes variability in typical conditions (7). Due of subjectivity, SCHIZAS is susceptible. Despite both systems having favourable associations with clinical measures including symptoms and functional impairment, the LEE system had a substantially better predictive value. Despite both systems working well, this happened. The statistical analysis revealed that the LEE system had higher inter-observer reliability (κ=0.85kappa = 0.85κ=0.85) than the SCHIZAS system (κ=0.78kappa = 0.78κ=0.78). Quantitative evaluations are better than qualitative ones, hence this conclusion is crucial. Yes, the SCHIZAS method grades in 6.2 and a half minutes, substantially faster than the LEE system's 10.2 and a half minutes. Thus, the SCHIZAS approach is better for daily use. The inquiry also highlighted practical issues related to each method. Due to its precision and consistency, the LEE technique is ideal for research and specialised contexts, but it may be challenging to apply in resource-constrained situations. This is because LEE requires complicated image processing technology. Easy to use and faster data processing make the SCHIZAS system ideal for clinical settings. Standardisation and observer training may reduce variation. In usual therapeutic situations, SCHIZAS is better. The study was limited by not included patients who had spine procedures or medical issues that prevented them from getting an MRI. The study also required to exclude low-quality MRI pictures, reduce convenient sampling bias, and exclude spinal surgery patients. These traits may affect the generalisability of the findings, especially in complex situations with many grading systems (8). When identifying severe stenosis, the LEE technique has higher sensitivity and specificity than SCHIZAS.

Contrasting the two methods proved these conclusions. Given this, the LEE approach is very useful in finding critical cross-sectional area measuring circumstances. Clinicians can use this quantitative tool to link structural changes to symptom severity. They can construct therapy regimens based on this correlation (20). LEE gives precise parameters for preoperative planning and patient counselling when treating severe stenosis surgically. These measurements can be used surgically. According to nerve root congestion and dural sac architecture visual evaluations, SCHIZAS is the best approach. For routine treatment, this visual evaluation method is fine. SCHIZAS emphasises visual judgements, which explains this outcome. Its user-friendliness and speed make it beneficial in hectic clinical circumstances where efficiency is crucial. Because SCHIZAS is qualitative, diagnosis is simplified, allowing quick decision-making without difficult measurements or expensive imaging equipment. The qualitative SCHIZAS technique allows this. Although the SCHIZAS system is slightly less precise than the LEE system, both grading systems have strong correlations with clinical outcomes like symptom severity and functional impairment, supporting their relevance in determining how LCS affects patient quality of life. The LEE system had stronger relationships with functional impairment ($r = 0.80$) and symptom severity ($r = 0.76$), compared to the SCHIZAS system ($r = 0.76$ and 0.78, respectively). The LEE system correlated with symptom severity. So, while both methods are reliable, the LEE system's quantitative method has a somewhat higher prediction value for clinical symptoms. Because of its practical advantages, especially its speedy implementation, the SCHIZAS system, on the other hand, is an equally vital instrument in clinical settings when time is a restrictive element (23). This is because to the fact that it can be constructed incredibly quickly.In comparison to the SCHIZAS system, which

had a lower level of inter-observer reliability (κ=0.78kappa = 0.78κ=0.78), the LEE system displayed a greater level of inter-observer reliability (κ=0.85kappa = 0.85κ=0.85). Quantitative measures are characterised by their intrinsic objectivity, which is reflected in the high level of reliability that those measurements exhibit. The LEE system is particularly well-suited for multicenter research and scenarios in which it is critical to collect reliable data from a range of observers. This is related to the fact that it involves a variety of distinct observers.

However, the SCHIZAS technique uses visual evaluations, which are subjective and may cause unpredictability, especially in borderline cases. This is especially true when the severity is unknown. This is especially critical when the magnitude of the situation is unclear. This is especially true when right and wrong are often indistinguishable. Through standardised training and precise grading, the SCHIZAS system can be improved. The research also illuminates practical implications for each grading system. The LEE method grades in 10.5 minutes, with a 2.3-minute standard deviation. Despite the precision of LEE. Advanced imaging, which may not be available in all therapeutic settings, is also needed. (24). Although it relies on quantitative data, it requires more knowledge, which may restrict its utility in resource-constrained circumstances. Because of its quantitative data dependence. However, the SCHIZAS system's qualitative approach and rapid grading time (6.2 minutes with a standard deviation of 1.5 minutes) make it ideal for routine clinical examinations. Although each of these grading systems has advantages, they both have drawbacks that must be considered. Easy sampling in the research project may have introduced selection bias, limiting the generalisability of the findings. The exclusion of patients with poor MRI scans, spinal operations, and MRI contraindications

may have skewed results. This is because these events often mimic real-world therapeutic difficulties. By resolving these limitations in later research, it will be possible to gain a more comprehensive understanding of the systems' applicability across a wide variety of patient populations. This study has opened up several new avenues for future research and clinical innovation, which will be discussed below. One promising approach is to create AI-based tools that seamlessly integrate the LEE and SCHIZAS grading systems. Such tools may employ machine learning to analyse MRI images. These tools would integrate quantitative and qualitative attributes to deliver reliable, uniform grading with little observer bias. This would greatly enhance diagnostic precision and efficiency, allowing doctors to focus on patient treatment rather than visual interpretation.

To determine the predictive ability of both grading systems for clinical outcomes over time, longitudinal studies are needed. This area includes surgical and non-surgical therapy response, symptom progression, and quality of life. Knowing the prognostic implications of each grade system may improve patient outcomes for the different therapy options available. Since the LEE and SCHIZAS systems have complementing qualities, an integrated approach may yield the best results. With the accuracy of the LEE system and the practicality of the SCHIZAS system, doctors may be able to detect lumbar canal stenosis more accurately. This is achievable because these two systems function together. To attain this goal, accuracy and productivity must be balanced (9,11). LEE, like pre-surgical exams, can be used for in-depth investigations, while SCHIZAS can be used for initial evaluations and routine follow-ups. Both systems are usable. Each system has similar capabilities. Both systems can be used. Grading data can be used with other clinical factors to increase diagnosis accuracy. These contain the patient's physical exam

results and findings. This work has major implications for musculoskeletal radiography and chronic spine condition treatment. I must emphasise that these implications are significant. Orthopaedic surgeons, physiotherapists, and radiologists must work together to evaluate grading results in the context of the patient's clinical image. Because grading affects the patient's entire clinical picture. The rising prevalence of lumbar canal stenosis, caused by ageing and sedentary lifestyles, highlights the need for reliable and effective diagnostic methods. In order to improve diagnostic tools and patient care in this complex field of medicine, this study will compare the LEE and SCHIZAS grading systems' strengths and drawbacks. The study examines the pros and cons of both methods and emphasises patient involvement in diagnosis. Understanding the relationship between grading findings and patient pain, functional disability, and quality of life may help customise treatment and improve patient satisfaction. Precision medicine personalises patient care. Precision medicine aims to provide tailored medical care, hence these patient-centered techniques are appropriate.

This comparative analysis of the LEE and SCHIZAS grading systems for MRI-based lumbar canal stenosis diagnosis examines their diagnostic accuracy, reliability, clinical correlation, and practicability. Here, we summarise the study's findings, contextualise them, and discuss their implications for clinical practice and future research. All of this happens inside the larger literary setting(12-17).

The study population of 222 patients had a mean age of 55.4 years, a mean BMI of 27.3 kg/m2, and 57.7% males. Patients averaged 55.4 years old. These parameters match the demographic profile of LCS patients from prior studies. Lower back pain was reported by 91% of patients, followed by neurogenic claudication (75.2%) and radiculopathy (58.1%).

We concur with LCS's clinical presentation, which involves mechanical compression of brain regions causing discomfort, functional impairment, and reduced quality of life. Mechanical cerebral compression characterises LCS's clinical appearance. Since the average symptom duration is 18.6 months, LCS is chronic. This emphasises the importance of quick accurate diagnosis for proper therapy.

After analysing patient distribution across the LEE and SCHIZAS grading systems, moderate stenosis (Grade 2 LEE and Grade B SCHIZAS) was shown to be the most common severity level. Infection was linked to 35.1% and 37.8% of cases at this level. Mild stenosis often causes considerable discomfort but not severe functional impairment. The natural history of LCS demonstrates that mild stenosis often has severe symptoms. According to LCS's natural history, this distribution matches the findings. The statistical analysis shows a good positive correlation ($r = 0.82$, $p < 0.001$) between the two approaches, indicating consistency in stenosis severity classification. However, the LEE system had superior inter-observer reliability ($\kappa = 0.85$), compared to the SCHIZAS system ($\kappa = 0.78$). The quantitative component of the LEE system eliminates subjectivity during interpretation, which is presumably why. This supports previous research showing that quantitative grading methods improve diagnostic consistency. These findings support the current finding.

Both grading schemes showed that symptoms and functional impairment increased with grades as the trial progressed. This was true regardless of approach. Symptom severity ratings in the LEE system ranged from 4.2 ± 1.3 (Grade 1) to 8.9 ± 1.7 (Grade 4). Scores for one-day internationals rose from $21.4\% \pm 6.7\%$ to $62.3\% \pm 12.5\%$ overall. The SCHIZAS system showed a similar pattern, with symptoms worsening from Grade A (4.3

± 1.2) to Grade D (8.8 ± 1.6). Additionally, ODI scores increased from 20.9% ± 6.2% to 63.5% ± 11.8%. Similar patterns were seen. These findings show that higher grades are linked to higher disability and symptom burden, demonstrating the practicality of both systems in predicting patient outcomes. Grading systems influence treatment decisions and illness progression, as shown by their strong correlation with clinical outcomes. The association lends credibility to these systems.

LEE exhibited a slightly greater sensitivity (89%) and specificity (85%) than SCHIZAS (86% and 82%, respectively). This was shown by the LEE system's better accuracy. According to these data, the LEE technique may be slightly more accurate at detecting severe stenosis while reducing false positives. However, both methods performed well diagnostically, making them reliable LCS evaluation tools. The LEE method's quantitative approach may help it make more accurate stenosis assessments. Quantitative grading systems outperform qualitative ones in diagnostics, according to studies. These and those findings are related.

Each image took 10.5 ± 2.3 minutes for the LEE system and 6.2 ± 1.5 minutes for the SCHIZAS system. This shows a large gap between the systems. This difference may limit the LEE system's applicability in big clinical settings due to its thorough measurements. However, the qualitative approach of the SCHIZAS system allows for faster assessments, making it more suitable for regular use. Practitioners must balance diagnosis accuracy and time management when choosing a grading system. When resources are scarce, the SCHIZAS system may be better. In specialised centres with extensive reviews, the LEE system may be chosen.

MRI, with a 95% sensitivity and 90% specificity, is the most reliable imaging modality for lateral sclerosis (LCS) diagnosis. On the other hand, 500 meters costs more.

In resource-constrained environments, the use of X-rays may limit accessibility due to limited feasibility (500).CT scans and X-rays are cheaper ($300 and $100, respectively) and can be used as early tools, despite their low accuracy. MRI is still the best way to detect lower limb sclerosis (LCS), especially in cases that require detailed anatomical examination. These data support MRI usage. Imaging modality should be chosen based on therapeutic environment, resources, and patient needs.(21)

Here, observer-to-observer variation's variability and dependability are discussed.

The LEE method demonstrated strong inter-observer reliability in all grades ($\kappa = 0.88$ for Grade 1 to $\kappa = 0.75$ for Grade 4). The SCHIZAS method showed moderate reliability ($\kappa = 0.85$ for Grade A, $\kappa = 0.72$ for Grade D). The slight decrease in reliability for higher grades in both methods may be due to more subjective interpretation of severe stenosis. Anatomically complicated and overlapping, severe stenosis may be harder to discern. Both systems maintained remarkable consistency, proving they may be used in clinical situations. These findings show that standardised training and protocols reduce inter-observer variability, especially for greater stenosis grades. This highlights the importance of these aspects.

Long-term effects and survival rates of affected population

The LEE system has slightly higher survival rates than SCHIZAS at every time point. Survival rates consistently declined over time, according to the study. Within a year, LEE

had a 60% survival rate and SCHIZAS 58%, indicating a similar illness course. This applied to both systems. These findings indicating higher stenosis grades are associated with worse long-term results emphasise the need of precise grading in treatment decisions. Accurate grading helps guide treatment decisions. The LEE method may have improved diagnostic accuracy, allowing for more precise detection of severe stenosis and faster treatment. The LEE system's somewhat greater survival rates may be due to this.

The grading systems' ability to complement clinical evaluations was shown by the majority of patients' great satisfaction or satisfaction. This applies to most patients. Ten patients, a small number, complained about the diagnostic process. This shows that most patients liked the diagnostic process. This shows the importance of dependable grading systems to build patient trust in care. Based on the favourable feedback gathered during this research, uniform grading systems may improve patient experiences. Positive feedback suggests that patient happiness is essential to healthcare delivery.

Many crucial elements are lacking from this study. First, while the sample size is sufficient, it may not capture all LCS presentation changes. The second problem is that the study was conducted in one location, which may limit its generalisability.

CONCLUSIONS

Magnetic resonance imaging can be used to diagnose lumbar canal stenosis using LEE and SCHIZAS grading systems. Each system offers various benefits to the user during the diagnostic process. The LEE method is suitable for comprehensive clinical and research evaluations because it uses a quantitative approach. This method improves diagnostic precision and consistency, making it suitable for the above situations. However, it requires more exact measurements and time, which may limit its applicability in clinical settings with many patients or in fast-paced workplaces. Interpreting the LEE system requires more knowledge due to its complexity. This may limit the system's use in locations with fewer resources or clinicians with less radiological experience.

Its qualitative and visually intuitive form makes it more efficient and practical for everyday clinical use, especially in resource-constrained or high-volume settings. The qualitative and visually intuitive SCHIZAS approach is unique. This is especially true when resources are few. Due of its ease of use, it may be the best alternative in these instances. Standardised medical professional training and MRI image interpretation standards can increase consistency and dependability.

LEE systems are preferable for research due to their precision and repeatability. This makes it better. It works well for investigations that demand exact and measurable judgements. If the SCHIZAS system is used for initial screening or fast evaluations and the LEE system for more in-depth investigations, a hybrid technique may be needed. In low-resource scenarios, the simple and easy-to-use SCHIZAS system may be best. Because the SCHIZAS system has similar traits.

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APPENDICES

ENGLISH CONSENT FORM

The study you are about to participate is a randomized control trial survey titled as;

"**Comparative Analysis of LEE and SCHIZAS Grading Systems in the MRI-Based Diagnosis of Lumbar Canal Stenosis**"

The study has no potential harm to participants. All data collected from you will be coded in order to protect your identity, and should not be disclosed to anyone. Following the study there will be no way to connect your name with your data. Your answers to the questions will not affect the quality of education given to you. Any additional information about the study results will be provided to you at its conclusion, upon your request.

You are free to withdraw from the study at any time. You agree to participate, indicating that you have read and understood the nature of the study, and that all your inquiries concerning the activities have been answered to your satisfaction.

NAME _____ **SIGNATURE**_____

DATE_____

URDU CONSENT FORM

میں_____ تصدیق کرتا/ کرتی ہوں کہ **محترم (Hammad Ahsan)**نے اپنی اس تحقیق

Comparative Analysis of LEE and SCHIZAS Grading Systems in the MRI-Based Diagnosis of Lumbar Canal Stenosis

.زیرنگرانی **(Dr. Tasra Bibi)**کے متعلق بتا دیا ہے۔ مجھے اس تحقیق کی نوعیت، مقاصد، احداف، توقعات، فوائد اور خطرات کے متعلق ، ۔ساری معلومات فراہم کر دی گئی ہیں

اس تحقیق کے دوران ساری معلومات صیغۃ راز میں رہیں گی اور مریض کا نام اور دیگر معلومات صرف تحقیق کے لیے استعمال ہوں گی۔مجھے یہ بھی بتا دیا گیا ہے کہ میں اس تحقیق سے متعلقہ ہر قسم کے سوال پوچھنے کا مجاز ہوں اور یہ تحقیق صرف ایک شخص ک مفاد میں نہیں ہے بلکہ بحسثیت مجموعی انسانیت کا مفاد اس سے وابسطہ ہے۔ تمام تفصیلات جاننے کے بعد یس تحقیق میں شامل ہونے یا نہ ہونے پر کسی کا قائل نہیں ہوں۔ اس تحقیق سے کسی بھی وقت علیحدہ ہونے پر مجھ پر کوئی پابندی نہیں ہو گی۔ میں بذاتِ خود بقائمی حوش و حواس

۔اور رضا مندی سے اس تحقیقاتی عمل میں شامل ہوتی/ ہوتا ہوں

---------- دستخط محقق

---------- دستخط شرکت کار

---------- تاریخ

DEMOGRAPHICS FORM & QUESTIONNAIRES

PERMISSION LETTER

ETHICS COMMITTEE LETTER

PLAGIARISM REPORT

DATA COLLECTION SHEET FOR SINGLE PATIENT

Comparative Analysis of LEE and SCHIZAS Grading Systems in the MRI-Based Diagnosis of Lumbar Canal Stenosis

MR No: _____

Age: _____

Gender: _____

Clinical Presentation:

Pain Distribution Lower Back / Buttocks / Thigh / Calf / Foot	
Back Pain (On scale 0-10)	
Leg Pain (On scale 0-10)	
Numbness (On scale 0-10)	
Weakness (On scale 0-10)	
Neurogenic Claudication (Present/Absent)	
Duration of Symptoms	

MRI Details

Image Acquisition Protocol: _____

Image Quality: (Circle one) Good / Fair / Poor

Imaging Details:

LEE Grading System	**Imaging Findings**
Measured Cross-Sectional Area of Dural Sac (mm^2)	
Assigned Grade[1]	

SCHIZAS Grading System	**Imaging Findings**
Dural Sac Appearance: Wide / Narrow	
Nerve Root Crowding	
Assigned Grade[2]	

[1]The LEE grading system's grades are defined as follows:

- Grade 1: Normal or mild stenosis, with a dural sac area greater than 100 mm^2
- Grade 2: Moderate stenosis, with a dural sac area between 76 mm^2 and 100 mm^2
- Grade 3: Severe stenosis, with a dural sac area between 51 mm^2 and 75 mm^2
- Grade 4: Extreme stenosis, with a dural sac area of 50 mm^2 or less

[2]The SCHIZAS grading system is defined as follows:

- Grade A: The dural sac is wide, with no or minimal crowding of rootlets
- Grade B: Mild crowding is present, with some separation of rootlets
- Grade C: Severe crowding, with no separation of rootlets
- Grade D: No visible rootlets, often described as the "white star" appearance.

DATA COLLECTION SHEET FOR TEN PATIENTS

	Gender	Symptoms							EE Grading System		SCHIZAS G	
		Pain Distribution	**Back Pain**	**Leg Pain**	**Numbness**	**Weakness**	**Neurogenic Claudication**	**Duration of Symptoms**	Measured Cross-Sectional Area of Dural Sac (mm^2)	Assigned Grade	**Dural Sac Appearance:** Wide / Narrow	**Ne Ro Cr g**