

INTER- AND INTRA- OBSERVER RELIABILITY OF MAGNETIC RESONANCE IMAGING FOR DIAGNOSIS OF LUMBAR FAR LATERAL DISC HERNIATION

Nguyen Ngoc Quyen^{1,2}, Nguyen Vu Hoang²,
Nguyen Thi Kim Hong¹, Nguyen Huong Lan¹

ABSTRACT

Objective: To determine the inter- and intra-observer reliability of MRI for diagnosis of lumbar far lateral disc herniation. **Method:** 27 patients in whom lumbar far lateral disc herniation was definitely diagnosed by operative findings at our department between May 2018 and December 2022 were included. The magnetic resonance images consisting of T1- and T2-weighted axial and sagittal images, and these were reviewed blindly and independently by three orthopaedic spine surgeons in a random manner. The images were interpreted as positive or negative for far lateral disc herniation on 2 different occasions 3 months apart. Results were analyzed using Cohen's kappa statistic, and strengths of agreements were determined using the Landis and Koch criteria. **Result:** The kappa values for inter-reader agreement averaged 0.234 (0.282, 0.111, and 0.308 respectively) on the first occasion, and 0.166 (0.249, 0.111, and 0.137 respectively) on the second occasion, with an overall mean value of 0.200. Thus, the strength of agreement was only slight-to-fair according to the Landis and Koch criteria. Kappa values for intra-reader agreement averaged 0.479 (0.488, 0.491, and 0.459 respectively), indicating moderate agreement. **Conclusion:** The present study indicates that magnetic resonance imaging is not a reliable imaging modality for diagnosing lumbar lateral disc herniation. It is necessary to

carefully evaluate the intra-foramina and extra-foramina of lumbar spine region on MRI of these patients and the spine surgeon should pay attention to the correlation between the clinical symptoms and MRI findings of these patients.

Keywords: Lumbar lateral disc herniation, Inter-observer reliability, Intra-observer reliability, Magnetic resonance imaging

I. BACKGROUND

Approximately 10% of symptomatic lumbar disc herniations are located within the neural foramen or laterally to it [1]. Far lateral disc herniation is referred to by several terms, such as foraminal, intraforaminal, far-lateral, and extreme-lateral, which indicate a disc herniation within or lateral to the boundaries of the intervertebral foramen or the lateral interpedicular compartment [2]. While magnetic resonance imaging (MRI) is considered a reliable method for diagnosing central and paracentral disc herniations, its reliability in diagnosing far lumbar disc herniation (LDH) has not been extensively reported, particularly in Vietnam.. Moreover, in theory, diagnosing far lateral lumbar disc herniation based solely on radiographic imaging without knowledge of the clinical symptoms is highly challenging. This is why we conducted this study, to provide additional evidence supporting this hypothesis. Thus, the objective of this study was to determine the inter- and intra-observer reliability of MRI in diagnosing lumbar far lateral disc herniation.

¹ 108 Military Central Hospital

² Thai Nguyen University of Medicine and Pharmacy

³ Phu Tho General Hospital

Responsible person: Nguyen Ngoc Quyen

Email: bsquyenptcs108@gmail.com

Date of receipt: 12/2/2024

Date of scientific judgment: 8/4/2024

Reviewed date: 15/4/2024

II. SUBJECT AND METHOD

2.1. Subject

This study included all patients who were suspected to have lumbar far lateral disc herniation based on MRI before surgery and subsequently confirmed by operative findings at a specific department between May 2018 and December 2022. Only patients who met the following criteria were selected for the study. Firstly, individuals with spinal tumors or spondylolisthesis at the same level as the far lateral disc herniation were excluded. Secondly, only those who had undergone an MRI of the lumbar spinal region, which included T1- and T2-weighted axial and sagittal images, and had sagittal images that covered all foraminal areas and the medial portion of the extraforaminal areas at the level and side of the far lateral disc herniation, were included.

2.2. Method

This study is a retrospective cross-sectional study which was received the approval of our Institutional Review Board.

Review and Interpretation of the MRI: The MRI images of the patients, consisting of T1- and T2-weighted axial and sagittal images, were reviewed in a blinded and independent manner by three spine surgeons. These surgeons had a minimum of five years of experience as independent spine surgeons at a department separate from the one where the patients were treated. It's important to note that the reviewers did not participate in

the care of the included patients or their selection. They were also unaware of any clinical, diagnostic, or treatment information related to the patients.

The reviewers were provided with information about the affected or suspected side and level (e.g., left L4-5), and they were asked to determine, based solely on the MR images, whether the patients were positive or negative for far lateral disc herniation at the specified level and side. Each of the three orthopedic spine surgeons independently reviewed the images and had the flexibility to change their opinion at any point during the interpretation session, which typically lasted several hours for each interpreter.

Furthermore, all three reviewers repeated this interpretive exercise after a period of three months using the same set of MRI images. This was done to assess the intra-observer reliability. During the second review, no information regarding the previous results was provided, and the process was organized in the same manner as the initial review.

Statistical Analysis: The three paired inter- and three intra-observer comparisons were analyzed using Cohen's kappa statistics, utilizing SPSS version 20.0. To assess the strength of inter- and intra-observer agreements, the Landis and Koch criteria [3] were employed. These criteria, outlined in Table 1, provide a framework for determining the level of agreement.

Table 1: Criteria of Landis and Koch[3] for Interpretation of the Strength of Agreement Determined with the Kapa value

Kappa value	Strength of Agreement
<0.00	Poor
0.00 – 0.20	Slight
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Substantial
0.81 - 1	Almost perfect

III. RESULTS

Among the 27 patients who were ultimately included in this study, there were 8 males and 19 females. The average age of the patients was 58 years, with a range of 32 to 79 years. The distribution of the patients according to the affected level was as follows: 6 patients were diagnosed at L3-4, 9 patients at L4-5, and 12 patients at L5-S1. In terms of the location of the disc herniation, 15 cases were primarily located in the extraforaminal zone, while 12 cases were

primarily located in the foraminal zone.

During the first review, the interpretations of the three reviewers were consistent for only 16 out of 27 patients, resulting in an agreement rate of 56.7%. Similarly, during the second review, the interpretations of the three reviewers matched for 17 out of 27 patients, representing a 59.4% agreement rate (Fig. 1). Therefore, the interpretations differed in less than half of the cases, indicating a lack of consensus among the reviewers (Fig. 2).

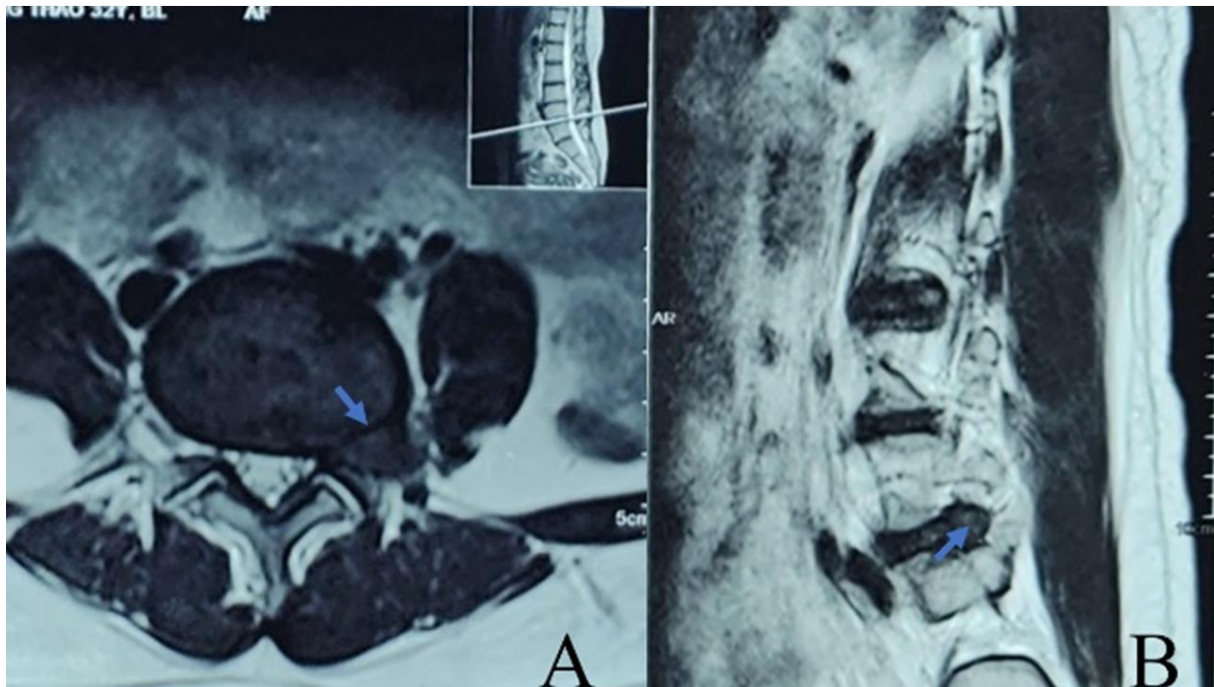


Fig 1. *The axial (A) and sagittal (B) MRI images of a 32-year-old woman are displayed. The images reveal an extraforaminal lateral disc herniation on the left side at the L4-5 level, as indicated by the blue arrows. All three readers independently interpreted this finding as positive for far lateral disc herniation during both image-reading sessions.*

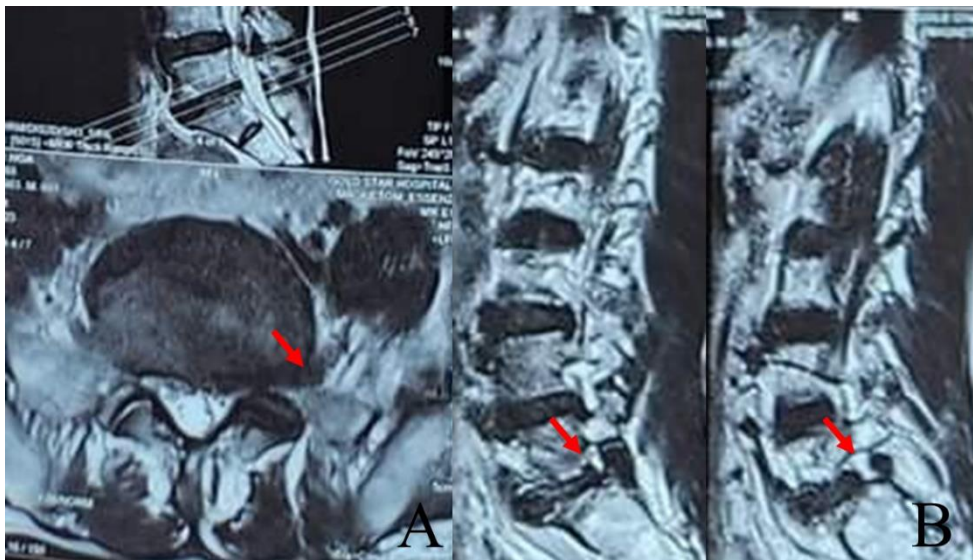


Fig 2: *The axial (A) and sagittal (B) MRI images of a 71-year-old man are presented. In the axial image (A), an extraforaminal lateral disc herniation on the left side at the L5-S1 level is suspected, as indicated by the red arrow. However, the sagittal image (B), which was obtained in the extraforaminal zone, does not provide clear evidence. These images resulted in different interpretations among the three readers during both reading sections. During the first reading, the interpretations were positive, positive, and negative, while during the second reading, the interpretations were negative, positive, and negative. This patient was ultimately diagnosed with far lateral disc herniation through operative findings*

The kappa values for inter-observer agreement between the three interpreters were calculated as follows (table 2): For the first review, the kappa values were 0.332, 0.337, and 0.400, with an average kappa value of 0.356. For the second review, the

kappa values were 0.408, 0.355, and 0.337, with an average kappa value of 0.367. The overall average kappa value, was calculated as 0.362. According to the Landis and Koch criteria [3], this kappa value indicates fair agreement among the three interpreters.

Table 2. Overall Kappa Values for Inter-observer Reliability

Observers	Kappa value of the first session	Kappa value of the second session	Mean
A and B	0.332	0.408	0.370
A and C	0.337	0.355	0.346
B and C	0.400	0.337	0.369
Mean	0.356	0.367	0.362

The kappa values for intra-observer agreement were determined as follows (table 3): The first reviewer had a kappa value of 0.577, the second reviewer had a kappa value of 0.400, the third reviewer had a kappa value of 0.503. The average kappa value for

intra-observer agreement was calculated as 0.487. According to the Landis and Koch criteria [3], this average kappa value indicates a moderate level of agreement among the reviewers for the second review.

Table 3. Overall Kappa Values for Intra-observer Reliability

Observers	Kappa value
A	0.577
B	0.400
C	0.503
Mean	0,487

IV. DISCUSSIONS

Failure to recognize the presence of extraforaminal disc herniation, with or without foraminal herniation, often leads to unfavorable outcomes and persistent sciatica, even following surgical intervention [4]. Therefore, extraforaminal disc herniation, whether accompanied by foraminal herniation or not, holds significant pathological importance, necessitating a precise pre-surgical diagnosis. However, the detection of these herniations is typically challenging. Grenier et al. [5] concluded that MRI is a valuable tool for analyzing extraforaminal disc herniation. They suggested incorporating a 15~30° angled frontal view, oblique caudally and anteriorly, following the course of the nerve roots. However, this specific image is not typically included in routine spine MRI protocols. Park et al. [6] also concluded that even high-quality standard MRI scans often fall short in diagnosing lumbar far lateral disc herniation. Kim et al. [7] reported kappa values for inter-observer agreement averaging 0.234 during the first assessment and 0.166 during the second, with an overall mean value of 0.200. These results indicate only slight-to-fair agreement among the observers. In terms of intra-observer agreement, the kappa values averaged 0.479, indicating moderate agreement. Their findings suggest that simple MRI is not a reliable imaging method for diagnosing lumbar far lateral disc herniation. In this present study, the overall average

kappa values for inter-reader and intra-reader agreement were 0.362 and 0.487, respectively, indicating fair and moderate agreement. The results of this study demonstrated better inter- and intra-reader agreement for MRI diagnosis of lumbar far lateral disc herniation compared to the findings of Kim et al. [7]. One possible reason for this difference is that in Kim et al.'s study, the patients included were suspected of having lumbar far lateral disc herniation without definitive confirmation. Conversely, in our study, the presence of lumbar far lateral disc herniation was definitively confirmed through operative findings.

Although our study demonstrated a higher level of inter- and intra-reader agreement for simple MRI in the diagnosis of lumbar far lateral disc herniation, it is important to note that this agreement still fell within the moderate range, as per the Landis and Koch criteria [3]. Hence, the diagnosis of lumbar far lateral disc herniation based solely on simple MRI remains a challenging task. In clinical practice, spine surgeons should thoroughly assess the correlation between the patient's clinical symptoms and the MRI findings. In cases where necessary, additional diagnostic methods should be employed to ensure an accurate diagnosis. Our study had several limitations that should be acknowledged. Firstly, the number of patients included in our study was small, which may limit the generalizability of

our findings. Secondly, we did not utilize a picture archiving and communication system (PACS) for the evaluation of MRI images, as our study was conducted retrospectively. This may have affected the efficiency and accuracy of our image analysis.

V. CONCLUSION

Based on the findings of our study, we have concluded that there is fair inter-observer agreement and moderate intra-observer agreement for the diagnosis of lumbar far lateral disc herniation using MRI. Therefore, it is crucial to conduct a thorough evaluation of the intraforaminal and extraforaminal regions of the lumbar spine on MRI in these patients. Additionally, spine surgeons should carefully consider the correlation between the clinical symptoms and MRI findings in order to make accurate diagnoses and treatment decisions for these patients.

REFERENCES

1. **Berra LV, Di Rita A, Longhitano F, Mailland E, Reganati P, Frati A, et al** (2021). Far lateral lumbar disc herniation part 1: Imaging, neurophysiology and clinical features. *World J Orthop* 12(12):961-9.
2. **Tessitore E, de Tribolet N (2004)**. Far-lateral lumbar disc herniation: the microsurgical transmuscular approach. *Neurosurgery* 54(4):939-42; discussion 942.
3. **Landis JR, Koch GG (1997)**. The measurement of observer agreement for categorical data. *Biometrics* 3(1):159-74.
4. **Moon KP, Suh KT, Lee JS (2009)**. Reliability of MRI findings for Symptomatic Extraforaminal Disc Herniation in Lumbar Spine. *Asian Spine J.* 3(1):16-20.
5. **Grenier N, Gréselle JF, Douws C, Vital JM, Sénégas J, Broussin J, et al (1990)**. MR imaging of foraminal and extraforaminal lumbar disk herniations. *J Comput Assist Tomogr* 14(2):243-9.
6. **Park SK, Yeom JS, Lee C, Chang BS, Lee JH, Lee JH, et al (2005)**. Diagnosis of Lumbar Lateral Disc Herniation: Value of Magnetic Resonance Imaging Revisited. *J Korean Soc Spine Surg* 12(1):28.
7. **Kim SW, Yeom JS, Park SK, Chang BS, Lee DH, Lee JH, et al (2009)**. Inter- and intra-observer reliability of MRI for lumbar lateral disc herniation. *Clin Orthop Surg* 1(1):34-9.