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MRI Based Diagnostic strategies for Lumbar Disc Herniation: A review

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Abstract

International medical organizations have reported that lower back pain (LBP) has been a common ailment for many years. One of the main causes of lower back pain (LBP) is lumbar disc herniation. It puts strain on the spinal nerves, resulting in leg pain, and occasionally necessitates surgery, which can be dangerous and fraught with problems. Patients thus urgently require an efficient diagnostic instrument. Despite the availability of data from X-ray and CT scans, magnetic resonance imaging (MRI) has emerged as the preferred diagnostic technique. This is because MRI provides more accurate imaging and a safer diagnosis. Therefore, researchers have focused on leveraging MRI data collected from hospitals at specific times to enhance medical investigations. This study looks at several techniques that researchers utilize to identify lumbar disc herniation. MRI is the only basis for the first method. By altering machine learning algorithms, the second technique increases the accuracy of diagnoses. The third approach integrates a number of methodologies into frameworks for machine learning. According to the findings of the literature analysis, machine learning models were able to

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diagnose lumbar disc herniation using MRI data with diagnostic accuracies ranging from 87% to 98%. This illustrates how developing models using cutting-edge machine learning techniques might result in more accurate diagnoses. Additionally, neither the training procedure nor the dependability of the diagnostic models were adversely impacted by the dataset's preponderance of MRI pictures.

Keywords: Magnetic Resonance Imaging (MRI); Lower Back Pain (LBP); Lumbar Disc Herniation; Deep Learning; Convolutional Neural Network (CNN); Medical imaging; Diagnosis; Artificial intelligence; transfer learning.

1.1 Introduction

As the population gets older, many chronic diseases are becoming more common because of changes in lifestyle and the rise of unhealthy habits. One of these widespread chronic conditions is lower back pain (LBP), which can lead to disability. With the population continuing to grow, this will create a major burden on the healthcare system [1].

Medical statistics show that by the year 2025, around 800 million people worldwide will suffer from this condition [2]. This has a negative impact on both society and individuals [3]. In 2017, the American Academy of Orthopaedic Surgeons (AAOS) reported that 80% of people in the United States experience lower back pain (LBP)[4].

In 2023, statistics showed that many people suffering from lower back pain (LBP) had a condition called disc herniation [5]. This happens when a soft, jelly-like center of a spinal disc pushes through cracks in its tough outer layer. If this material presses on the spinal nerves, it can cause pain and inflammation. This usually occurs in the lower back, especially in the The spinal cord's lumbar-sacral region. The shape, size, quantity, and appearance of herniated discs

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in the lumbar area vary widely, making treatment challenging. The disorder's severity is determined by the nucleus pulposus's status, as illustrated in Figure (1).

The disc exhibits a modest bulge and puts mild strain on the ligaments and spinal cord during the first stage, known as bulging, while the fibrous ring stays intact [6].

In the second stage (protrusion), the bulging disc tears the inner ligaments and presses on the spinal cord [7].

The disc material ruptures through all but the outer ligaments in the third stage (extrusion), putting significant strain on the spinal cord [8].

A free fragment of a herniated disc tears through the back ligaments and strikes the dural sac in the fourth stage [9].

The ability to diagnose illnesses quickly and accurately is one of the problems that global healthcare systems face. MRIs, CT scans, and X-rays are some of the techniques used to identify disc diseases. MRI is the most popular method for detecting disc herniation, although being more costly than the other methods [10]. Because it uses non-invasive, non-ionizing radiation and produces high-quality images, it is also used to identify a wide range of other disorders [11].

Because of this, it is now a crucial tool for determining whether conservative or surgical treatment is appropriate. Early detection of Lumbar Disc Herniation (LDH) is widely established [12].

shields the patient from dangerous consequences and aids in healing in the early stages of the illness [13].

This study's primary objective is to investigate and comprehend the strategies and tactics employed by researchers, as well as the outcomes they attained in the diagnosis of disc herniation. A related work is presented in section 2 of the rest of this paper and the outcome in Section 3.

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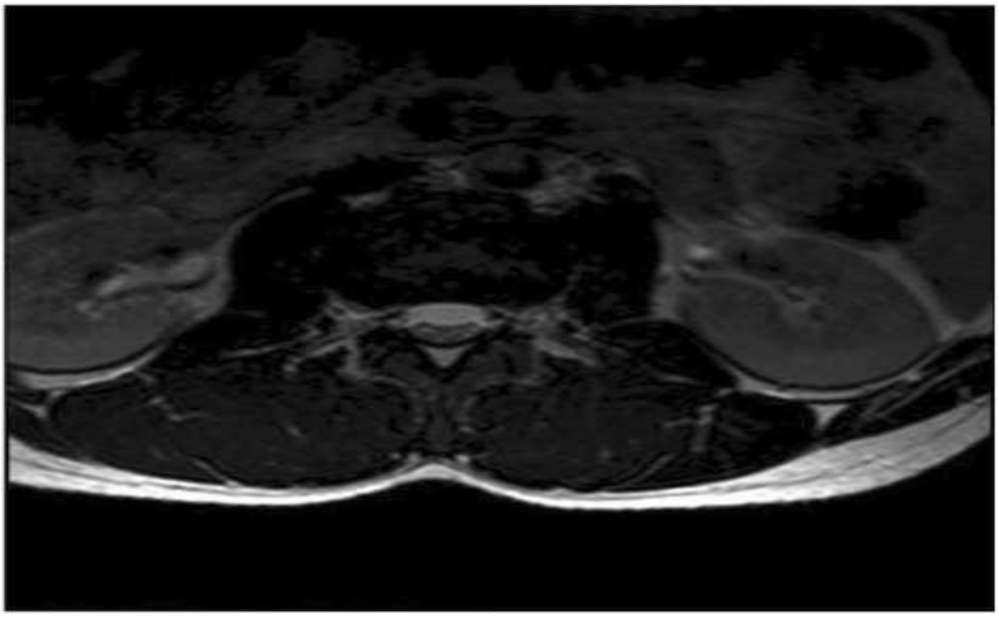

Figure 1. Axial MRI scan for lumbar disk herniation [1].

2.1 Related work

in 2020. Barki, Wafa M. et al. are using a modified version of the VGG19 model to diagnose disc herniation. 94% accuracy is attained in their work [12]. Zhengkuan Xu and Gang Chen at (2021). Their current working title is "U sage of intelligent medical aided diagnoses system under the deep convolution neural network in lumbar disc herniation" . An improved activation function T_relu is incorporated into a CDCGAN network architecture. The accuracy of the system is increased by 94.14% as a result [14].

During that same year, Tijana Sustersic et al. An automatic classification methodology. The title of the study was "Detecting disc herniation in segmented lumbar spine magnetic resonance images using distinct features" . The U_net convolutional neural network is employed. They obtained 92.5% accuracy results [15].

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"Automatically diagnosing disc herniation with lumbar magnetic resonance images by using deep convolution neural networks: method development study" was the draft title of a study conducted by Qiong Pan et al. that same year. To diagnose disc herniation MRI, they employ a deep convolutional neural network. As much as 92.7% accuracy is attained [13].

in 2022. Al-Smirat, Muhammad et al. A CNN model-based computer-assisted diagnosis system is being developed under the working title "Deep learning-Based disc herniation computer aided diagnosis system from MRI Axial scans" to diagnose lumber disc herniation from MRI axial scans. 95.65% system accuracy was the outcome [16].

Additionally, frisk Natalia et al. The working title is "Automated selection of mid-height intervertebral disc slisc in traverse lumbar spine MRI using a combination of deep learning feature and machine learning classifier" . After conducting an experiment, they discovered that the optimum method for extracting full-length picture features using a pretrained DenseNet201 model is to apply the support vector machine (SVM) algorithm with a short Gaussian kernel. This method yields an accuracy of 88% [10].

Additionally, Tijana Sustersic et al. The title of the project was "ADeep Learning Model for Automatic Detection and classification of Disc herniation in Magnetic Resonance Images" . To diagnose disc herniation, a comprehensive automated deep learning-based procedure is suggested. The accuracy result was 96.1% [17].

Zhi Hai Su et al. also published in the same year. For the automatic grading of lumber disc herniation MRI images, a multitask classification network is presented. Up to 87% accuracy was achieved [1].

in 2023. ChaoHou et al. They classify lumbar disc herniation MRIs using a semi-supervised approach. The title of the study was "An MRI image automatic diagnoses model for lumbar disc herniation using semi_ supervised learning" . A maximum of 87.11% was attained by the model [18].

Ardh Ardea etal was published in the same year. "An approach to the diagnoses of lumbar disc

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herniation using deep learning model" Images of disc herniation are classified using the Yolovx AUG model. 90% accuracy was achieved [2].

in 2024. Qian Jun et al. To segment and identify intervertebral disc herniation, a deep learning model based on U-net is built. "Lumbar disc herniation diagnoses using deep learning on MRI" was the working title. A 93.5% accuracy rate was attained by the model's construction [5]. Additionally, Angel G. Mehandzhiysk et al. "Machine learning predictive model for lumer disc herniation following microsurgical discectomy" is the working title. The risk_SLIM model is used by them. Up to 87% accuracy has been attained [19].

Additionally, Maad Ebrahim et al. "Advanced disc herniation computer aided giagnoses system" is the working title. The best results are obtained when they employ SVM after first using Resnet as a feature extractor. 98% accuracy was achieved [20]. Di Zhang et al. that same year. The proposed name was "A fully automatic MRI_guided decision system for lumbar disc herniation using machine learning" . The MSU classification and Pfirmann grading served as the foundation for the new system. 95% accuracy was achieved [21].

Zhang_Ming et al. that same year. The working title is "machine learning prediction model and risk factor analysis of RC operation in recurrent lumber disc herniation patient after percutaneous end scopic lumbar disctomy". The XGBOOST machine learning classifier model is employed. The accuracy result was 90.71%. [22].

Similarly, Zhiming Liu et al. The draft title is "Compare three deep learning based artificial intelligence models for classification of calcified lumbar disc herniation: amulticenter diagnostic study" . They used the ResNet-34 algorithm model to develop a deep learning model. They obtained a 91.67% accuracy rate.

[23].

in 2025. Abed, Mohammed A. et al. They used MRI images to identify lumbar disc herniation using the Yolo-v7 and Yolov8m method, which had an accuracy of 89.8% [24].

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Elzat elham-yilizati yilihamu etal was published in the same year. They classify disc herniation MRI images using the Yolova8 model. The working title was "Quantification and classification of lumbar disc herniation on axial magnetic resonance images using deep learning models" . 95% accuracy was achieved [4].

"Deep learning-based automatic detection and grading of disc herniation in lumbar magnetic resonance images" was the working title of Yan Guo et al. within the same year. Using the same dataset, they outperform the Yolov8 model. The GE_yolov8 model is the most recent. The new model's accuracy was 95%.[25].

2.2 Summary of previous works on disk herniation.

The following table displays the results of previous researchers working, showing each source, year of publication, type of study sample size and the technique was used. The accuracy metric was used to evaluate each study.

Work reference	Published year	Sample size	Type of study	Technique that used	Accuracy%
[12]	2020	1736	Experimental with cross-validation experiment	Vgg19 modified model	94
[14]	2021	6000	Experimental study	CDCGAN	94.14
[15]	2021	557	Experimental with cross-validation experiment	U-net convolution neural network	92.5
[13]	2021	3555	Experimental with cross-	Deep convolution neural network	92.7

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			validation experiment		
[16]	2022	164	Experimental with cross-validation experiment	CNN based model+ CAD system	95.64
[10]	2022	48345	Experimental with cross-validation experiment	Densenet + SVM	88
[17]	2022	575	Experimental with cross-validation experiment	Deep learning convolution	96.1
[1]	2022	15254	Experimental with cross-validation experiment	Automated grading model	87
[18]	2023	16707	Experimental study	Using semi supervised learning	87.11
[2]	2023	550	Experimental study	Yolov5xAUG model	90
[5]	2024	1552	Experimental with cross-validation experiment	Deep learning model based on U_ net	93.5
[19]	2024	230	Experimental with cross-	Risk_ SLIM model	87

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			validation experiment		
[20]	2024	236	Experimental with cross-validation experiment	ResNet + SVM	98
[D4]	2024	3255	Experimental with cross-validation experiment	Pfirmann grading + MSU classification	95
[D5]	2024	2603	Experimental with cross-validation experiment	XGBoost model	90.71
[23]	2024	1224	Experimental with cross-validation experiment	ResNet_34 model	01.67
[24]	2025	291	Experimental with cross-validation experiment	YoLo_v7 and Yolov_v8	93.7
[4]	2025	2500	Experimental with cross-validation experiment	YoLov8 model	95

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[25]	2025	1725	Experimental with cross-validation experiment	Yolov8 modification model	95

The table above, it is evident that source No.1 achieved the lowest accuracy in its model, while source No.20 achieved the highest accuracy by using a combined model of ResNet and SVM, despite having a smaller sample size compared to the others.

3.Conclusion and Discussion

The following points can be concluded from this work:

1) All researchers are used dataset types of MRI in their searches.

2) Most of researches are used CNN model from vgg19 type in their works.

3) The studies are used experimental study with cross validation experiment are achieved more accuracy than studies used data set experimentally only.

4) several of researchers are enhanced the accuracy by using CNN modified model or used CNN based model with other technique.

6) Machine learning models are more reliable diagnoses, therefore can assist the doctors in taking the surgical decision.

7) Reducing time and observer bias will alleviate the burden of clinical work.

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Reference

[1]: Ghosh, S., Raja'S, A., Chaudhary, V., & Dhillon, G. (2011, August). Composite features for automatic diagnosis of intervertebral disc herniation from lumbar MRI. In *2011 Annual*

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International Conference of the IEEE Engineering in Medicine and Biology Society (pp. 5068-5071). IEEE.

[2]: Prisilla, A. A., Guo, Y. L., Jan, Y. K., Lin, C. Y., Lin, F. Y., Liau, B. Y., ... & Lung, C. W. (2023). An approach to the diagnosis of lumbar disc herniation using deep learning models. *Frontiers in Bioengineering and Biotechnology*, *11*, 1247112.

[3]: Monzon, M., Iff, T., Konukoglu, E., & Jutzeler, C. R. (2025). Enhancing Low Back Pain Assessment with Diffusion Models for Lumbar Spine MRI Segmentation. In *Medical Imaging with Deep Learning*.

[4]: Yilihamu, E. E. Y., Shang, J., Su, Z. H., Yang, J. T., Zhao, K., Zhong, H., & Feng, S. Q. (2025). Quantification and classification of lumbar disc herniation on axial magnetic resonance images using deep learning models. *La radiologia medica*, 1-10.

[5]: Qian, J., Su, G., Shu, X., Shen, K., Chen, B., & Wang, X. (2024). Lumbar disc herniation diagnosis using deep learning on MRI. *Journal of Radiation Research and Applied Sciences*, *17*(3), 100988.

[6]: Al-Dulaimi, M. K. H., Al-Dulaimi, A. M., Al-Dulaimi, O. M., Abdulqader, A. F., & Zakharzhevskyi, A. (2024, April). Threats in Cloud Computing System and Security Enhancement. In 2024 35th Conference of Open Innovations Association (FRUCT) (pp. 82-93). IEEE.

[7]: Hatem, F., Alatba, S. R., Abdullah, M. Y., Nimchenko, T., & Myronchenko, A. (2024, April). A Method of Removing Rain or Snow from A Color Image using MATLAB. In 2024 35th Conference of Open Innovations Association (FRUCT) (pp. 222-231). IEEE.

[8]: Jawad, H. M., Hasan, H. A., Abdulqader, A. F., Kovalevskaya, L., & Kozubtsov, I. (2024, April). The detection of brain tumors user interface for MATLAB. In 2024 35th Conference of Open Innovations Association (FRUCT) (pp. 319-327). IEEE.

[9]: Abdulqader, A. F., Abdulrazzaq, A. Q., Alchalabi, M. Z. A., Jawad, A. M., Hamid, A. S., Khlaponin, Y., & Abdalhussein, E. (2024, October). 5G and the Internet of Things Collaborate to Improve Smart Glasses for

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the Visually Impaired. In 2024 36th Conference of Open Innovations Association (FRUCT) (pp. 159-167). IEEE.

[10]: Natalia, F., Young, J. C., Afriliana, N., Meidia, H., Yunus, R. E., & Sudirman, S. (2022). Automated selection of mid-height intervertebral disc slice in traverse lumbar spine MRI using a combination of deep learning feature and machine learning classifier. *PLoS One*, *17*(1), e0261659.

[11]: Rasol, M. A., Abdulqader, A. F., Hussain, A., Imneef, Z. M., Goyal, B., Dogra, A., & Mittal, M. (2024, March). Exploring the Effectiveness of Deep Reinforcement Learning for Autonomous Robot Navigation. In 2024 11th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions*)(ICRITO)* (pp. 1-5). IEEE.

[12]: Mbarki, W., Bouchouicha, M., Frizzi, S., Tshibasu, F., Farhat, L. B., & Sayadi, M. (2020). Lumbar spine discs classification based on deep convolutional neural networks using axial view MRI. *Interdisciplinary Neurosurgery*, *22*, 100837.

[13]: Pan, Q., Zhang, K., He, L., Dong, Z., Zhang, L., Wu, X., ... & Gao, Y. (2021). Automatically diagnosing disk bulge and disk herniation with lumbar magnetic resonance images by using deep convolutional neural networks: method development study. *JMIR medical informatics*, *9*(5), e14755.

[14]: Chen, G., & Xu, Z. (2021). Usage of intelligent medical aided diagnosis system under the deep convolutional neural network in lumbar disc herniation. *Applied Soft Computing*, *111*, 107674.

[15]: Sustersic, T., Rankovic, V., Milovanović, V., Kovacevic, V., Rasulic, L., & Filipovic, N. (2022). Detecting Disc Herniation in Segmented Lumbar Spine Magnetic Resonance Images using Distinct Features.

[16]: Alsmirat, M., Al-Mnayyis, N., Al-Ayyoub, M., & Al-Mnayyis, A. A. (2022). Deep learning-based disk herniation computer aided diagnosis system from mri axial scans. *IEEE Access*, *10*, 32315-32323.

ISSN: 2392- 5418 e-ISSN: 2520- 7423 DOI:10.59799/SQZH5356

[17]: Šušteršič, T., Ranković, V., Milovanović, V., Kovačević, V., Rasulić, L., & Filipović, N. (2022). A deep learning model for automatic detection and classification of disc herniation in magnetic resonance images. *IEEE Journal of Biomedical and Health Informatics*, *26*(12), 6036-6046.

[18]: Hou, C., Li, X., Wang, H., Zhang, W., Liu, F., Liu, D., & Pan, Y. (2023). An MRI image automatic diagnosis model for lumbar disc herniation using semi-supervised learning. *Complex & Intelligent Systems*, *9*(5), 5567-5584.

[19]: Mehandzhiyski, A. G., Yurukov, N. A., Ilkov, P. L., Mikova, D. P., & Gabrovsky, N. S. (2024). Machine learning predictive model for lumbar disc reherniation following microsurgical discectomy. *Brain and Spine*, *4*, 103918.

[20]: Ebrahim, M., Alsmirat, M., & Al-Ayyoub, M. (2024). Advanced disk herniation computer aided diagnosis system. *Scientific Reports*, *14*(1), 8071.

[21]: Zhang, D., Du, J., Shi, J., Zhang, Y., Jia, S., Liu, X., ... & Feng, S. (2024). A fully automatic MRI-guided decision support system for lumbar disc herniation using machine learning. *JOR spine*, *7*(2), e1342.

[22]: Shan, Z. M., Ren, X. S., Shi, H., Zheng, S. J., Zhang, C., Zhuang, S. Y., ... & Xie, X. H. (2024). Machine learning prediction model and risk factor analysis of reoperation in recurrent lumbar disc herniation patients after percutaneous endoscopic lumbar discectomy. *Global Spine Journal*, *14*(8), 2240-2251.

[23]: Liu, Z., Zhang, H., Zhang, M., Qu, C., Li, L., Sun, Y., & Ma, X. (2024). Compare three deep learning-based artificial intelligence models for classification of calcified lumbar disc herniation: a multicenter diagnostic study. *Frontiers in Surgery*, *11*, 1458569.

[24]: Abed, M. A., Al-Qaysi, Z. T., & Suzani, M. S. (2025). Improving Lumbar Disc Bulging Detection in MRI Spinal Imaging: A Deep Learning Approach. *Al-Salam Journal for Engineering and Technology*, *4*(1), 1-19.

[25]: Guo, Y., Huang, X., Chen, W., Nakamoto, I., Zhuang, W., Chen, H., ... & Wu, J. (2025). Deep learning-based automatic detection and grading of disk herniation in lumbar magnetic resonance images. *Scientific Reports*, *15*(1), 24700.