

Development of a Machine Learning-Based Methodology for Accurate Staging of Lumbar Intervertebral Disc Degeneration using T2-Weighted Magnetic Resonance Imaging (MRI) and Radiomics Features

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Determining the stages of Lumbar Inter-vertebral Disc Degeneration (LIVDD) correctly is important for accurate diagnosis. This study sought to develop a robust methodology combining advanced image analysis techniques and machine learning to assess disc degeneration stages using T2-weighted Magnetic Resonance Imaging (MRI) data. A fine-tuned dataset of 100 Digital Imaging and Communications in Medicine (DICOM) images representing different stages of degeneration was subjected to radiomics feature extraction by 500 regions of interest (ROIs) using manual segmentation. Stage evaluations were obtained for each ROI by a radiologist. Machine learning models (Support Vector Machine (SVM), Decision Tree, Random Forest) were trained on the training set (80% for training and 20% for testing from the raw data). A comparative analysis of the model predictions and expert judgments were performed for performance evaluation, by the accuracy of the test set. The models were repeatedly trained by selecting the features that give the highest accuracy through several different feature selection methods (Odds ratio and PCA). Principal Component Analysis (PCA) showed that feature selection method was more accurate. It was able to achieve 63% accuracy for SVM model, 57% accuracy for Decision tree model and 67% accuracy for Random Forest model. Findings underscore the potential of machine learning in accurate and efficient staging. Strengths and limitations of the methodology provides a basis for future refinement. This study marks an important step towards the integration of innovative techniques in spine health assessment, towards precise and personalized patient care.

Keywords: *Lumbar Inter-Vertebral Disc Degeneration (LIVDD), T2-Weighted MRI, radiomics, machine learning, feature selection, diagnostic accuracy*