Diagnostic Interpretation of Perfusion Lung Scans Using Multifractal Texture Analysis

We investigated the feasibility of using multifractal texture analysis for detection and characterization of lung diseases from perfusion lung scans. Forty-five perfusion scans were acquired from patients with clinical suspicion of acute pulmonary embolism (PE). They were all part of complete ventilation-perfusion (V-P) lung studies which were considered indeterminate for PE and therefore the patients were referred to pulmonary angiography for final diagnosis. An experienced nuclear medicine physician extracted 24x24 pixel regions of interest (ROIs) from the posterior view of the perfusion scans. There were 270 ROIs in total: 94 normally perfused ROIs and 176 abnormal ROIs representing lung diseases including PE, obstructive lung disease, atelectasis, pleural effusion, and opacity. The true diagnosis was established based on the patients' complete radiographic studies and pulmonary angiograms. Multifractal analysis was then performed on each ROI using the circularly averaged power spectrum technique. Subsequently, a feed-forward artificial neural network (ANN) was developed based on multifractal parameters to predict the presence and potentially type of disease present in each ROI. The diagnostic performance of the ANN was evaluated using Receiver Operating Characteristics (ROC) analysis and the leave-one out sampling method. Based on four multifractal parameters, the ANN achieved a statistically significantly better ROC area index ($Az=0.92\pm0.02$) than the single fractal dimension ($Az=0.87\pm0.02$) in predicting the presence of lung disease. The ANN also showed promise in identifying specifically the presence of PE in ROIs without additional information from ventilation scans and chest radiographs.