

Technical development of artificial intelligence in magnetic resonance spectroscopy

Hyeong Hun Lee

METLiT Inc., Seoul, Republic of Korea

ABSTRACT

This study investigates the application of Deep Learning (DL) techniques for enhancing Magnetic Resonance Spectroscopy (MRS) analysis of brain metabolites, with a focus on neurodegenerative diseases. MRS, a non-invasive tool capable of detecting around 20 metabolites in the human brain, faces challenges in clinical settings due to data quality variability and analysis software selection. By employing a fine-tuned Bayesian Convolutional Neural Network (BCNN) trained on an extensive in-silico MRS dataset, this study aims to improve the quantification of brain metabolites, thereby facilitating the diagnosis and study of degenerative brain diseases. The methodology involved multi-institutional MRS analyses on a cohort of healthy adults and examination of natural variations in brain metabolites in the posterior cingulate cortex among different ages. The study also includes a literature review on brain metabolites associated with neurodegenerative diseases. Results demonstrated that the proposed method significantly outperformed the traditional LCModel in quantification accuracy, reducing coefficients of variation and detecting metabolite changes associated with aging more effectively. Notably, the DL-aided analysis revealed statistically significant changes in nine brain metabolites, compared to only three identified by the LCModel. The findings highlight the DL approach's superior generalization performance and its potential for precise detection of metabolite changes. Furthermore, the literature review identified key metabolites such as N-acetylaspartate, myo-Inositol, gamma-aminobutyric acid, glutathione, glutamate, and glutamine, emphasizing their importance in diagnosing and understanding neurodegenerative diseases. In conclusion, DL-enhanced MRS analysis holds promise for medical research and clinical applications, particularly in identifying metabolite biomarker for neurodegenerative diseases.