Editorial for "Deep Learning-Enabled Identification of Autoimmune Encephalitis on 3D Multi-Sequence MRI"

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While the concept of neural networks and deep learning was already introduced 50 years ago, it really started to gain attention in the last decade due to the enormous increase of computing power. In the context of radiology, deep learning shows great promise in lesion detection, segmentation, and classification problems. For example, deep learning techniques have shown good diagnostic accuracy for liver and prostate cancer, as well as pulmonary disease.[1] Moreover, deep learning methods have also shown potential in the diagnosis of several brain disorders, such as Alzheimer's disease, Parkinson's disease, autism spectrum disorder, and schizophrenia.[2]

Acute encephalitis is an inflammation of the brain, which can be caused by a viral infection such as the herpes simplex virus or an abnormal immune response (autoimmune encephalitis). A timely diagnosis of acute encephalitis is vital, as treatment delays worsen prognosis and increase the risk of severe disability or even death.[3] However, discriminating herpes simplex virus encephalitis (HSVE) from autoimmune encephalitis is complicated as they share similar clinical and radiological characteristics. Moreover, since polymerase chain reaction tests for HSVE can be false-negative during the first 72 hours,[4] timely diagnosis is complicated. Commonly observed cerebral changes in HSVE and autoimmune encephalitis are hippocampus-related changes, hyperintense lesions in white matter, demyelination, and inflammatory processes.[5] Magnetic resonance imaging (MRI) is usually incorporated into the standard diagnostic procedure, although in the early stages of the disease conventional MRI can appear normal, or shows non-specific changes, complicating a timely and accurate diagnosis.[6]

In this issue of *JMRI*, a study by Xiang et al[7] investigated the potential benefit of deep learning techniques in a retrospective study for an early diagnosis of autoimmune encephalitis using multiple MRI contrasts.

They included 160 patients with autoimmune encephalitis, 177 HSVE patients, and 184 healthy controls. Moreover, to test the generalizability of their approach, an additional external validation set from another site was also collected. This set consisted of 15 patients with autoimmune encephalitis, 17 HSVE patients, and 20 healthy controls.

For all subjects, T1-weighted, T2-weighted, fluid attenuated inversion recovery (FLAIR), and diffusion-weighted images were acquired. Subsequently, the bilateral hippocampi were manually delineated and used as input for the deep learning model, as this region is known to be involved in encephalitis. To ensure that enough training data were available for the deep learning model, common data augmentation techniques were used to magnify the dataset up to eight times.

The authors used an adjusted ResNet-18 network architecture and showed that the hippocampal features had high diagnostic power, resulting in area under the curve (AUCs) of 0.83 for autoimmune encephalitis and 0.88 for HSVE. Moreover, using the external validation set, similar AUCs (0.83 and 0.88) were reported, indicating that their results are generalizable. Furthermore, the accuracy of the proposed model outperformed the accuracy of three trained radiologists (83% vs. 72%).

Taken together, this study demonstrates the potential that multiparametric MRI combined with deep learning techniques has for the diagnosis of encephalitis. An extension upon the current work could be to include the clinical information of the patients in the deep learning model as well, since this information also has diagnostic power.[8] Additionally, instead of only using the hippocampal regions as an input, future studies could evaluate the whole brain, and use unsupervised, data-driven methods to identify relevant regions. As MRI changes also occur beyond the hippocampus, such as white matter lesions, demyelination, and inflammatory processes, potentially valuable information might not be included when only focusing on the hippocampus.

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DOI: 10.1002/jmri.27951

Level of Evidence: 3
Technical Efficacy Stage: 2