Intravoxel incoherent motion

To overcome a limitation of Diffusion weighted magnetic resonance imaging DWI in glioma diagnosis, which is that perfusion can substantially confound diffusion measurements because of the incoherent motion of blood, intravoxel incoherent motion (IVIM) based on DWI is proposed [1) 2)]

Intravoxel incoherent motion (IVIM) imaging is a concept and a method initially introduced and developed by Le Bihan et al. to quantitatively assess all the microscopic translational motions that could contribute to the signal acquired with Diffusion weighted magnetic resonance imaging. In biological tissue, these motions essentially are molecular diffusion of water and microcirculation of blood in the capillary network (perfusion). The concept introduced by D. Le Bihan is that water flowing in randomly oriented capillaries (at the voxel level) mimics a random walk (“pseudo-diffusion”)

It is responsible for a signal attenuation in diffusion MRI, which depends on the velocity of the flowing blood and the vascular architecture. Similarly to molecular diffusion, the effect of pseudodiffusion on the signal attenuation depends on the b value. However, the rate of signal attenuation resulting from pseudodiffusion is typically an order of magnitude greater than molecular diffusion in tissues, so its relative contribution to the diffusion-weighted MRI signal becomes significant only at very low b values, allowing diffusion and perfusion effects to be separated.

A study reported a first attempt to address this issue, only parameter differences between low-grade glioma and high grade gliomas were reported, and there was no information regarding the suitable cutoff values of the suggested differentiating parameters [3)].

This imaging is useful in differentiating high-grade gliomas (HGGs) from low-grade gliomas (LGGs) [4) 5)].

Case series

Fifty patients, 17 with PCNSL and 33 with GBM, were retrospectively studied. From the 3 Tesla IVIM data, the perfusion fraction (f) and diffusion coefficient (D) were obtained. In addition, the maximum standard uptake value (SUVmax) was obtained from the FDG-PET data. Each of the three parameters was compared between primary central nervous system lymphoma (PCNSL) and GBM using Mann-Whitney U-test. The performance in discriminating between PCNSL and GBM was evaluated using receiver-operating characteristics analysis and area-under-the-curve (AUC) values for the three parameters.

The fmax and Dmin values were significantly higher in GBM than in PCNSL ($P < 0.01$ and $P < 0.0001$, respectively). In addition, the SUVmax value was significantly lower in GBM than in PCNSL ($P < 0.0005$). The AUC values for fmax , Dmin , and SUVmax were 0.756, 0.905, and 0.857, respectively. The combination of the fmax and Dmin increased the diagnostic performance (AUC = 0.936) of fmax ($P < 0.05$), but this value was not significantly different from the values for Dmin ($P = 0.30$).

IVIM-MR imaging noninvasively provides useful quantitative information in distinguishing between PCNSL and GBM [6)].

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