Positron emission tomography combined with diffusion tensor imaging reveals macrostructural breakdown around epileptic foci in non-lesional medically refractory epilepsy.

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Purpose: Multimodal brain imaging combining positron emission tomography (PET) and magnetic resonance imaging (MRI) may improve detection of the epileptic focus (EF) in MRI-negative medically refractory epilepsy prior to surgical resection. In patients with no visible lesions, ^{18}F-fluorodeoxyglucose PET (FDG-PET) can detect a potential EF as brain areas showing decreased FDG uptake. Diffusion tensor imaging (DTI) is an advanced MRI technique that can assess white matter (WM) integrity around the EF. This study combined FDG-PET and DTI to investigate WM integrity in the brains of MRI-negative medically refractory epilepsy patients. The potential clinical impact of combined PET/DTI on epilepsy surgical evaluation was also assessed.
Method: FDG-PET and DTI data were simultaneously acquired from 14 MRI-negative or equivocal epilepsy patients using a 3T hybrid PET/MRI scanner (Biograph mMR, Siemens Healthineers, Erlangen, Germany). Asymmetry index mapping was used to detect the EF as the brain area showing the largest decrease in FDG uptake compared to the contralateral homologous brain region. Seed-based fiber tracking was initiated in WM 3 mm from the EF. Fiber tracking was repeated in the contralateral homologous brain region, which served as an inherent control for this study. WM integrity around the EF was assessed qualitatively by a senior neurologist and quantitatively through WM fiber measurements (mean fractional anisotropy, fiber count, and mean fiber length).
Results: Mean fractional anisotropy, fiber count, and mean fiber length were decreased in WM around the EF in 14/14 (100%), 13/14 (93%), and 12/14 (86%) patients, respectively. Visual assessment of WM fibers improved the neurologist's diagnostic confidence in 10/14 (71%) patients and informed potential reassessment for surgical candidacy in 50% of the patients who had not undergone surgery.
Conclusion: Combined PET/DTI is a feasible method for investigating WM integrity in MRI-negative epilepsy patients and can be used to improve epilepsy surgical evaluation.