FAST FIELD-CYCLING MRI IDENTIFIES ISCHAEMIC STROKE AT ULTRA-LOW MAGNETIC FIELD STRENGTH

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Introduction: Fast Field-Cycling MRI (FFC-MRI) is a novel MRI technique in which the external magnetic field is switched during the imaging experiment. By doing this, FFC-MRI gains access to information which is invisible to conventional MRI scanners, including the variation of $T_1$ with magnetic field. In this work we aimed to assess whether we can identify recent cerebral infarcts at ultra-low field strength, when compared with conventional imaging.

Methods: After informed consent, a group of patients (n=24) with ischemic stroke were scanned within 24-96h of presentation. The FFC-MRI examination took 45 minutes, and included FFC images at five evolution fields (0.2 mT to 0.2 T). Patients also had CT and/or 3T MRI images available.

Results: In patients with sub-acute ischaemic stroke, $T_1$-weighted FFC-MRI images exhibited hyperintense regions, with contrast increasing markedly as the evolution magnetic field strength decreased, to a maximum at the lowest field used (0.2 mT). The infarct region measured by FFC-MRI correlated well with the abnormality in CT and/or Diffusion Weighted images (DWI) (Examples in Fig. 1,2).

Discussion: This is the first-ever clinical application of this new modality, proving that FFC-MRI can generate diagnostic-quality images of ischaemic stroke at ultra-low magnetic fields (e.g. 0.2 mT), with significantly enhanced endogenous $T_1$-contrast compared to conventional MRI. These exciting findings have implications for future development of a new and safe imaging modality not only for stroke but many other clinical conditions.

Fig. 1. CT, 3T DWI MRI and FFC MRI images from a 67 year old male admitted with a right occipital infarct. a) CT at 24 hours after onset, b) 3T DWI image at 78 hours after onset, c-f) FFC-MRI inversion-recovery images at the level of the lesion at 200mT, 50mT, 2mT and 0.2mT respectively (75 hours after onset).

Fig. 2. CT, 3T MRI and FFC MRI images from a 50 year old male admitted with a posterior inferior cerebral artery territory infarct. a) CT at 24 hours after onset, b) 3T DWI image at 96 hours after onset, c) 3T $T2$ weighted image at 96 hours after onset, d-g) FFC-MRI inversion-recovery images at the level of the lesion at 200mT, 2.2mT, 2mT and 0.2mT respectively (90 hours after onset).

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References