Purpose: To develop a high-resolution, multimodal and translatable imaging protocol to characterize experimental models of traumatic brain injury (TBI). Small animal imaging modalities include fluorodeoxyglucose (FDG)-positron emission tomography (PET) with computed tomography (CT) and magnetic resonance imaging (MRI).

Methods: Male Sprague-Dawley rats were exposed to either lateral fluid percussion (LFP) or controlled cortical impact (CCI) TBI with mild or moderate severity. Baseline FDG-PET and MRI scans were conducted prior to injury and at various times post-TBI. FDG-PET/CT images were acquired on a Siemens Inveon Multimodality scanner based on IV injection of 37 – 74 MBq (1 – 2 mCi) of FDG. Diffusion, perfusion, and spectroscopic images along with susceptibility and T1/T2-weighted images were acquired on a Bruker Biospec 7T/20 cm magnet running Paravision 5.1.

Results: For translatable FDG-PET imaging, a tail vein injection of FDG with 45 minutes of anesthetized uptake and 30 minutes of scanning was optimal. With the brain centered in the field of view, uptakes (ipsilateral and contralateral) were normalized by cerebellar uptake since blood sampling was not conducted. The 2-hour MRI protocol included fast spin echo (100 um), 3D multi-echo gradient echo susceptibility (100 um), 4-shot EPI-based continuous arterial spin labeling (152 um), 8-shot EPI-based with three direction diffusion (100 um), and single voxel PRESS spectroscopy(3 mm).

Conclusions: The impact of TBI on military service members is significant with more than 5,500 soldiers diagnosed with TBIs. Early diagnosis and development of an effective treatment for veterans with TBI is a priority for the military. A multimodal and multi-parameter imaging protocol for experimental TBI that is both translatable and efficient (high throughput) is pivotal for studying neuroprotection, regeneration, and plasticity. An optimized small animal imaging protocol was developed to investigate longitudinal changes in glucose utilization (FDG-PET/CT), cortical volume, diffuse axonal injury, perfusion, and metabolite concentration (MRI).

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