

**Purpose:** To develop and evaluate an integrated multi-modal image guidance methodology for DBS.

**Method and Materials:** An image guidance methodology was developed to integrate multiple imaging methods as well as atlas and intraoperatively acquired electrophysiology data. Imaging techniques were developed using a 3T MRI to provide unique contrast of specific structures in the brain. A new sequence, the Fast Grey matter Acquisition T1 Inversion Recovery (FGATIR), was developed to produce images that specifically nullified the white matter signal. In addition, diffusion tensor imaging (DTI) tractography was acquired to provide differentiation of target subregions through structural connectivity. These imaging techniques as well as standard (T1, T2 FLAIR, and CT) imaging protocols were integrated on a single platform. This integration was accomplished by the development of a graphical user interface (GUI) to allow for viewing and targeting based off these images along with a deformed atlas and intraoperatively acquired electrophysiology maps.

**Results:** The developed image guidance system allowed for targeting based off all data types mentioned previously. The new imaging techniques developed were compared against intraoperatively acquired microelectrode data. The two novel imaging techniques, FGATIR and DTI tractography, provided elucidation of structure not seen by standard imaging methods and showed good correspondence with microelectrode maps. Contrast measurements for the FGATIR versus T1 and T2 FLAIR showed a higher contrast to noise ratio (CNR) for FGATIR scans. For example, the CNR for ventral lateral thalamus versus the remainder of thalamus was 2.19, 2.81, and 7.27 for T1, T2 FLAIR, and FGATIR, respectively.

**Conclusion:** Our methodology for image guidance in DBS surgery has the potential to allow for direct visualization and targeting of regions that can not be visualized by standard techniques. The integration of all these methods within a single framework demonstrates the potential for multi-modal image guidance in neurosurgery.