17.6T MR Microscopy of Movement Disorders as a Guide For Deep Brain Stimulation

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Introduction

The basal ganglia are a group of deep brain structures that play a pivotal role in select cases of movement disorders like Parkinson's disease and essential tremor. Neuronal circuit theories have been put forth to explain the etiology of many of the symptoms of these diseases. We hypothesized that a higher magnetic field scanner such as a 17.6T MR Microscopy will visualize the details of neuronal circuits in the basal ganglia. In 2013, we scanned brains from Parkinson's disease patients as well as "normal" controls on the 17.6T MR scanner. Over the course of the past year we have begun imaging post-mortem Parkinson's disease patients' brains on a 3T MR scanner and then correlating regions of interest (subthalamic nucleus, globus pallidus interna, thalamus) with 17.6T MR microscopy. It is important that the structures that they are targeting on the basis of 3T MRI is confirmed and validated to be, in actuality, the targeted structure of interest (e.g. subthalamic nucleus, globus pallidus, thalamus). By correlating areas of interest on the 3T images with those that are delineated to a much greater degree with 17.6T MR microscopy, we are able to validate that the targeted areas on 3T are indeed within the bounds of the structure that the neurosurgeons intend to target.

Results and Discussion

We obtained a 3T sequence of a post-mortem brain from a patient with DBS for Parkinson's disease. We will use this sequence (figure 1) to confirm the structures (subthalamic nucleus) that we targeted for lead placement by comparing the 3T image with the image we will acquire using 17.6T MR microscopy. Previously we had scanned five brain hemispheres from Parkinson's disease patients, and three non-pathological brain hemispheres. The T2 weighted image at 25 μm thickness provided the best quality images, and a DTI analysis revealed details of the fiber pathways in the region of interest (Figure 2- below).

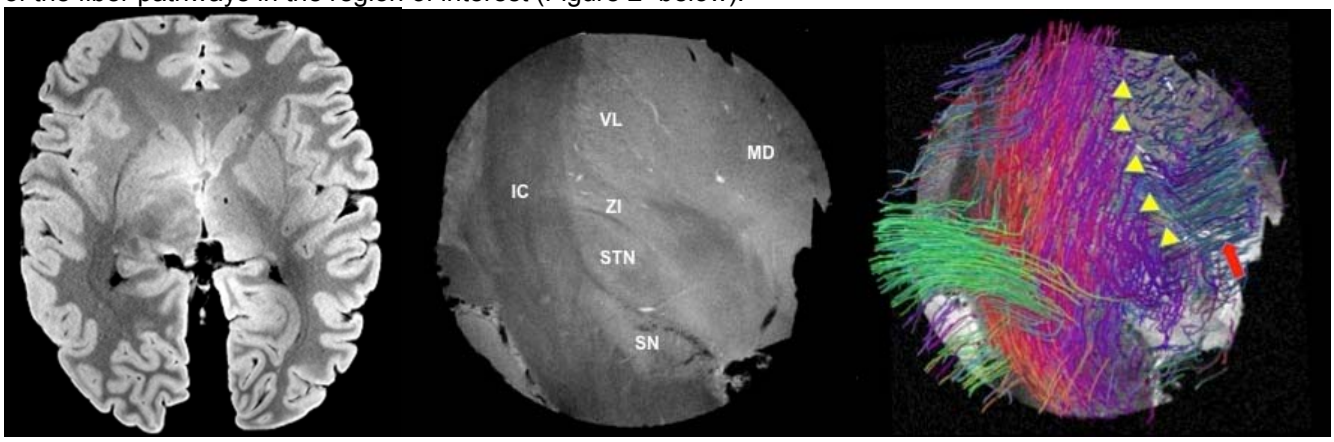

FIGURE 1 Left: T1 axial image of post-mortem brain from a patient with DBS for Parkinson's disease. **Center:** T2-weighted image. **Right:** Fibertractography superimposed on the T2-weighted image. The purple fibers indicated by yellow arrowheads are branched from the cerebral cortex into ventrolateral (VL) nucleus of the thalamus and the subthalamic nucleus (STN). The blue fibers indicated by a red arrow are derived from mediodorsal thalamic nucleus (MD) to form the anterior thalamic peduncle.

Conclusions

3T scanning in conjunction with 17.6 T MR microscopy will assist in validating structures targeted clinically during Deep Brain Stimulation lead implantation. We will continue to expand the strength of our results by comparing images with data collected from excised tissues after deep brain stimulation electrode placement, and determine the ability of MRI to improve the location of said electrodes and evaluate the successfulness of electrode placement as a guide to improving clinical outcome.

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