Wide-Bore MRI Guided DBS Surgery: Initial Experience

Karl K Vigen[1], Deborah Rusy[2], Laura Buyan-Dent[3], Nancy L Ninman[3], and Karl A Sillay[4,5]

[1]*Radiology, University of Wisconsin-Madison, Madison, WI, United States,* [2]*Anesthesiology, University of Wisconsin-Madison, Madison, WI, United States,* [3]*Neurology, University of Wisconsin-Madison, Madison, WI, United States,* [4]*Semmes-Murphy Neurologic and Spine Institute, Memphis, TN, United States,* [5]*Neurosurgery and Electrical Engineering & Computer Science, University of Tennessee, Memphis, TN, United States*

Target Audience Scientists and clinicians interested in MRI-guided interventions.

Purpose Neuromodulation using Deep-Brain Stimulation (DBS) technology is used as a treatment for movement disorders such as Parkinson's Disease (PD), essential tremor, and dystonia, and is beginning to be used for other conditions. Conventional DBS surgery typically requires the patient to be awake and off medication, and uses indirect targeting with a frame-based approach and electrophysiological monitoring. Recently, an FDA-approved system with during-procedure MRI-guidance and direct targeting has been used, allowing patients to undergo the procedure under general anesthesia while inherently accommodating brain shift[1]. A large number of sites have now installed the system; and initial results from one institution using one MRI vendor's platform are promising[2]. The purpose of this study is to report the initial experience and accuracy of the trajectory guidance from an additional institution using a different MRI vendor's platform.

Methods The MRI-guided targeting system (ClearPoint, MRI Interventions, Memphis, TN) was installed in a specially-designed MR-OR suite, which included a 1.5T wide-bore (70 cm) system (Optima MR 450w, GE Healthcare, Milwaukee, WI). A six-channel flexible surface coil was positioned between the patient's head and the head fixation device (HFD) (Fig 1); imaging sequences were similar to those used in previous studies [1]. A total of 16 patients (9M, 7F; average age 66, range 38-74) underwent MRI-guided DBS implantation between April 2011 and September 2014. All patients were being treated for PD with the subthalamic nucleus (STN) as the target; 15 had bilateral leads implanted, and 1 had a single lead implanted, for a total of 31 leads. Patients were divided into an initial group of 4 patients, who had the procedure performed in 2011, and for which a three-point HFD (Mayfield, Integra, Plainfield, New Jersey) was used; and a second group of 12 patients in 2012-2014 for which a more rigid 4-point HFD (MRI Interventions, Memphis, TN) was used (Fig 1). For all patients, special attention was paid to table positioning to avoid potential errors introduced by table movement during the procedure.

Results For all 31 leads, the location of the tip of the ceramic stylet measured with the guidance system's software (Fig. 3) had a mean radial error in the target plane of 1.0+/-0.5 mm (range 0.1-2.4mm) compared with the prescribed target point. Separated by group, the mean radial error was 1.1+/-0.5mm for the initial group (8 leads), and 0.9+/-0.5mm for the second group (23 leads). Procedure time for the MRI-guided sections of the procedure averaged 487 minutes for the first group, and 257 minutes for the 11 patients with bilateral implants in the second group.

Fig 1 4-pt HFD with 6-ch Coil.

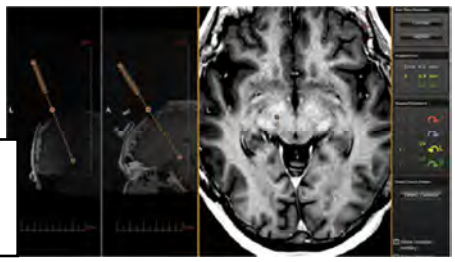

Fig 2 Final Trajectory Calculation.

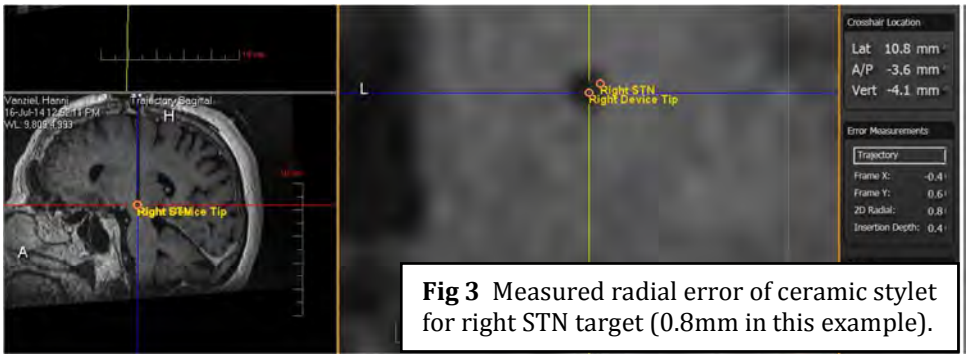

Fig 3 Measured radial error of ceramic stylet for right STN target (0.8mm in this example).

Discussion and Conclusions

Procedure times improved with the second group, which might be due to a learning curve, or the use of an improved head fixation device. Measured mean radial error can be compared with previous reported values for this procedure (0.6+/-0.4mm, Martin et al. [2]); mean trajectory errors of 1.24 ± 0.87 mm for one CT-based approach[3]; and final lead positioning errors of 2-3mm often reported for other frame-based and frameless approaches[4]. Potential sources of discrepancy between institutions might include differences in the MRI vendors' platforms; RF receive coil selection and setup; patient setup; and the relative frequency at which procedures are performed by the operating team.

References [1] Larson PS, *et al, Neurosurgery* **70**(ONS Suppl 1);95 (2012). [2] Martin A, *et al, Proc. 20th ISMRM,* 211 (2012). [3] Burchiel KM *et al, J Neurosurg* **119:**301–306 (2013). [4] Vega RA *et al, Neurosurg Clin N Am* **25**:159–172 (2014).