Vagus Nerve Stimulation in patients: a BOLD fMRI study

Wen-Ching LIU1, Kristine MOSIER2, Andrew KALNIN3, David MARKS4

1University of Medicine and Dentistry of New Jersey, New Jersey Medical School, Department of Radiology, Newark, NJ USA; 2University of Medicine and Dentistry of New Jersey, Department of Radiology, Newark, NJ USA; 3University of Medicine and Dentistry of New Jersey, 150 Bergen street, Newark, NJ USA; 4UMDNJ-NJMS, Department of Neurosciences, 150 Bergen street, Newark, NJ USA;

Introduction
Vagus nerve stimulation, (NeuroCybernetic Prosthesis system, NCP), is a newly approved treatment for uncontrolled partial seizures [1]. However, the underlying mechanisms of the therapy are still unclear. The on-off switch for NCP has a magnetic control, which makes an MR or fMRI study difficult. In order to study the stimulation response in the brain with the MR scanner, a technique to assure the device will be switched to ON position is developed. The purpose of this study is using fMRI to detect the associated activated regions in the brain associated with stimulation from the vagus nerve stimulator

Methods
A total of six patients (4 male and 2 female, mean age = 36) with an NCP device implanted were enrolled for the study. Based on our earlier study, the device can be switched on in the magnet if the device is positioned in the direction parallel to the z-axis of magnet [2]. All the subjects had the device implanted in the parallel direction except for one subject. The timing control of the device was set to 30 sec ON and 66 sec OFF before the subject entered the MR scanner.

The functional MRI was performed on GE 1.5T Echospeed Horizon. The scanning parameters are: TR/TE= 4000/60, FOV=24 cm, 64 x 64 matrix size, 28 slices continuously with 5 mm slice thickness. The functional scan started 30 sec after patient reported the stimulated sensation. The entire run consisted of a 66 sec baseline followed by 4 cycles of 30 sec ON and 66 sec OFF periods. Three runs were collected for each patient. The data were off-line reconstructed, normalized to Talairach brain and statistical processing for activation using SPM99 [3]. Statistical significance was set to a threshold of p < 0.02. The data was analyzed individually as well as a group.

Results
One subject who had the NCP device implanted in other direction reported that no stimulation happened in the scanner. All other five subjects had stimulation from the NCP in the scanner. The average activation areas were identified from group study as in the temporal, angular, and supramarginal gyrus, and parietal, occipital, insular lobes for activation and cingulate gyrus for deactivation.

Conclusion
The preliminary BOLD fMRI study suggests that the activation related to vagus nerve stimulation from NCP could be reliably detected, if the device was implanted properly. The activation areas detected were partially in agreement with the published data [4].

References