

**Title: Presurgical Brain Mapping: Resting State MRI**  
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**Highlights:**

- Task based fMRI is an established technique for mapping eloquent cortex.
- Resting state fMRI (RS-fMRI) methods are currently under investigation.
- The clinical application of RS-fMRI to the mapping of eloquent cortex is a new method under investigation with some advantages over current techniques.

**Target Audience:** This information will be beneficial to clinicians or researchers that use fMRI methods to map areas of eloquent cortex in the brain.

**Objectives:** The learner will gain understanding of clinical applications of RS-fMRI.

**Purpose:** Currently, a challenge in the surgical treatment of brain tumors is to preserve eloquent areas of brain function while maximizing the extent of resection. The current gold standard for localization of eloquent cortex is direct electrocortical stimulation (ECS), during an awake craniotomy where the patient is able to participate in various cognitive tasks [1]. The requirement for patient cooperation limits its use in a significant number of patients (e.g. children and medically tenuous patients) and thus may prohibit an optimal resection for these individuals. Similarly task fMRI requires patient cooperation. Resting state functional connectivity MRI (fcMRI) has emerged as an alternative method for localization of brain networks that requires no active patient participation and can be done under sedation [2,3]. The purpose of this study was to explore the use of fcMRI for localization of eloquent cortex in patients with epilepsy and brain tumors [4].

**Methods:** 6 patients with intractable epilepsy and 7 patients with brain tumors were selected for the study. Epilepsy patients had electrocorticographic monitoring using an implanted grid to localize the epileptogenic zone of seizure onset and to perform functional mapping with ECS. Patients with tumors underwent intra-operative ECS mapping prior to resection of the tumor mass. Resting state fMRI data was acquired and pre-processed as per prior protocols [3,4]. Location of the motor and language system was determined using a multi-layered perceptron (MLP) [5]. A comparison was performed between the localization of the motor and language systems using ECS and RS-fMRI via the MLP algorithm.

**Results:** In the epilepsy patients we were able to perform a quantitative analysis by comparing the localization of the eloquent networks using the MLP with the localization on the different grid electrodes. By adjusting the probability threshold for classifying an electrode as eloquent or not we were able to calculate receiver-operator curves (ROC) with an average area under the curve (AUC) of 0.89 for the motor network and 0.76 for the language network. The results from the tumor patients were more qualitative. Networks were preserved in the presence of a tumor, though they were often shifted with respect to their normal anatomic position.

**Discussion:** In the current study [4] RS-fMRI has demonstrated utility as an adjunct tool for eloquent cortex localization. We have also determined that a “no-cut” criteria of 15mm around the contour of the network determined from the MLP will limit the false negative probability to less than 2%. Minimizing the MLP false negative results are critical to reduce surgical morbidity, since resection of a false negative area could lead to a clinical deficit.

**Conclusion:** RS-fMRI can provide useful information on the location of eloquent cortex for pre-surgical planning and can be performed in many patients that can't benefit from traditional fMRI.

**References:** [1] Sanai N et al., N Engl J Med 2008; 358:18-27. [2] Shimony JS et al., Academic Radiology 2009, 16(5):578-583. [3] Zhang D et al., Neurosurgery 2009; 65:226-236. [4] Mitchell T et al. Neurosurgery 2013, 73(6):969-83. [5] Hacker C et al. Neuroimage 2013, 82:616-33.