

**Specialty Area: Advanced Neuroimaging 1: Brain and Spinal Cord**  
**Title: Resting State Functional Connectivity fMRI for Presurgical Brain Mapping**  
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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 (DECS), 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 prohibits 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 brain tumors.

**Methods:** 8 subjects with a new diagnosis of brain tumor were recruited prior to surgery. Normal controls were scanned identically as part of a different study. In addition to anatomic imaging, subjects were also scanned using BOLD sensitized resting state fMRI on a 3T Siemens Allegra MR. For comparison, subjects were also scanned using a block design motor and language tasks, which were processed using standard techniques. Resting state analysis was performed using several alternative methods: 1) A seed-based approach by placing seeds in the undistorted contralateral side of the brain. 2) An artificial neural network technique trained on normal brains to identify standard resting state networks. In several subjects the analyzed data was transferred to the intra-operative navigation system in order to compare the results with the gold standard DECS.

**Results:** The somatomotor cortex was consistently identified in all subjects using seed placement in the hand motor area in the undistorted side contralateral to the tumor using atlas coordinates. Identifying the language network required a more variable set of tools, depending on the tumor location. Placement of a seed region in Broca or Wernicke's regions was not always possible when tumors cause severe distortion of the left hemisphere. ICA analysis provided a robust alternative method of identifying the language network in distorted brain. Following identification of components of the language networks in ICA, these were checked by placement of seed regions and by comparison with the task based fMRI scans.

**Discussion:** Direct comparison was not always possible, due to various factors. In some cases the awake craniotomy technique had to be aborted due to risk to the patient's airway, or inability of the patient to cooperate with the intraoperative stimulation techniques. In the cases in which direct comparison was possible, there was close correspondence between the different localization methods. In at least 2 cases in which the task based fMRI was not diagnostic, the RS-fMRI was useful as a back up tool, and enabled the surgeon to perform a more complete resection of the tumor, without morbidity and with good outcomes.

**Conclusion:** RS-fcMRI 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.