

# Diffusion Tensor-Based Tractography and Transcranial Magnetic Stimulation Correlate with Electrocorticographic Phase Reversal for Localization of the Central Sulcus and Motor Mapping in Young Children

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17

10 (59%)

2.9

17 7



### Introduction

Incomplete myelination during early life limits direct cortical electrical stimulation (DCES) effectiveness and subsequent motor mapping. Higher stimulation thresholds and repeated attempts, especially in epileptic children, can provoke seizures, edema and cortical injury. Diffusion tensor image (DTI) based tractography measures changes in water diffusion and fractional anisotropy between white/gray matter. Transcranial magnetic stimulation (TMS) approximates motor cortex by measuring electromyographic responses. Both modalities can map motor pathways during surgical planning. Here, we tested whether DTI and TMS could accurately localize Rolandic cortex in young children with immature white matter.

### **Methods**

Motor pathway localization by pre-operative DT tractography was conducted in 17 children who were undergoing surgery for resection of epileptic foci. Four patients also had motor cortex identified by preoperative TMS. Intraoperative electrocorticographic recordings were used to localize the central sulcus at the point of phase reversal between the primary sensory and motor cortices. This location was identified on stereotactic neuronavigation imaging and compared to pathways predicted by preoperative DTI and TMS.

### **Results**

The average subject age was 2.9 years. In all 17 cases, DT tractography accurately identified the motor cortex in relation to the central sulcus confirmed by intraoperative phase reversal-based localization of the central sulcus and motor mapping. The 7 patients undergoing TMS had accurate trilocalization of their motor cortex as well.

# **Demographics:**

- Patients (n):
- % Male (n, %):
- Avg Age (yrs):
- DTI and DCES (n):
- TMS (n):
- All patient underwent craniotomy for epilepsy, tumor or cavernous malformation resection

### **Transcranial Magnetic Stimulation**

During TMS, the stereotactic MRI is registered to the child and loaded on the the TMS system. Each stimulation point is recorded stereotactically and can be coded based on positive or negative motor responses by electromyographic recording to map the motor cortex non-invasively. All recording is done on awake, non-sedated patients while they interact with their parents and/or watch videos, ultimately creating a topographical map of the motor cortex, which is registered and visible on the neuronavigation system intraoperatively.



Stimulation sites are mapped to stereotactic MRI

## Motor Outcomes:

- No deficit:
- Transient defict with full recovery: 5
- Permenant deficit:



8



Representative sample showing phase reversal occuring between electrodes 2 and 3 (left) and intraoperative navigation softward showing motor tracts as reconstructed from diffusion tensor images.

### Conclusions

DTI, TMS, and DTI/TMS together, are useful and accurate methods to non-invasively localize the central sulcus in very young children with incomplete myelination and in whom intraoperative motor mapping would be inconclusive or not technically possible. Our results demonstrate direct correlation of these non-invasive methods with phase reversal during intraoperative mapping.

Mapping with DTI and TMS allow safe resection of lesions near the motor cortex, with overall excellent outcomes in motor function.

DTI and TMS may replace DCES for motor cortex mapping in the future, reducing the risk of intraoperative seizures.