

# Diffusion tensor imaging assessment of epileptogenic zone using RNS depth electrode locations to investigate white matter networks

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## Abstract

**Background:** In patients with drug-resistant epilepsy, RNS (Responsive Neurostimulation), which delivers stimulation to perturb the onset of ictal activity is an effective therapy to manage seizures. This study seeks to identify whether RNS contacts that are associated with clinical benefit are associated with conserved white matter bundles in the brain. Diffusion tensor imaging (DTI) has been used to estimate and model white matter tracts of the brain, allowing for 3D visualization of brain region connections and networks. To date, the combination of patient-specific brain imaging and 3D extracted depth electrode contacts and white matter tracts has not been used to build patient-specific seizure network models. Here, we combined these methods to define the epileptogenic zone in order to investigate and potentially locate shared networks across patients with drug-resistant epilepsy that predict susceptible networks.

**Methods:** We obtained pre-operative MRI with DTI and post-operative CT in epilepsy patients (n = 8) managed with RNS systems with. Implanted RNS probe contacts were segmented from the post-operative CT images. The diffusion images were rotated and scaled to the space of the post-operative CT imaging using DSI studio. Each individual RNS contact within the hippocampal region was used to define unique tract bundles. A deterministic fiber tracking algorithm was used with augmented tracking strategies to improve reproducibility. A one-way Anova test was run with "Hemisphere" (left vs right) and "Contact Region" (anterior vs posterior) used as grouping variables.

**Results:** The values of the individual fiber tracts' mean length (mm), span (mm), curl, and elongation were determined and recorded along with their associated hemisphere and contact region. Based on the one-way Anova, there was no evidence for shared fiber tracts between the subjects of this study. This is strongly plausible given the subjectivity of RNS placement.

**Conclusion:** DTI white matter tractography has proven its usefulness in clinical applications and while its utilization has increased in past years, when combined with other diagnostic tools, it has a much wider array of applications in clinical practice. Further investigation is needed to utilize the physiologic information recorded by the RNS system (cortical stimulation, seizure activity recordings) in conjunction with the anatomical models.