



# Spinal Cord Stimulation and functional MRI: Pain relief correlates with decreased connectivity between somatosensory and limbic brain networks

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## Introduction

The aim of this study was to use resting state functional MRI (rs-fMRI) to detect changes in cortical networks and cortical processing linked to pain relief from spinal cord stimulation.

## Methods

10 patients who have thoracic epidural spinal cord stimulators were enrolled in this IRB approved study. Stimulation parameters associated with "optimal" pain reduction and SCS perception threshold were evaluated prior to imaging studies. rs-fMRI was obtained on a 3 Tesla, Philips Achieva MRI. The safety of MRI scanning with SCS was determined previously. rsfMRI was performed with stimulator off (300TRs), at sensory perception threshold (Low, 300 TRs) and at optimum (Opt, 300 TRs) therapeutic settings. Seed-based analysis of the resting state functional connectivity was conducted using seeds in regions linked to the pain networks or in the default mode network. NCUT parcellation was used to generate 100 cortical and subcortical regions of interest in order to expand analysis of changes in functional connections to the entire brain. We corrected for multiple comparisons by limiting the false discovery rate to five percent.

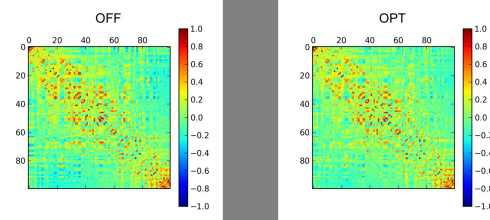
## Reported Pain Change

Subject	$\Delta P\%$
1	40%
2	0%
3	29%
4	71%
5	50%
6	27%
7	75%
8	30%
9	70%
10	60%

Pain reduction with stimulator turned on at the optimum position in comparison to the Off state

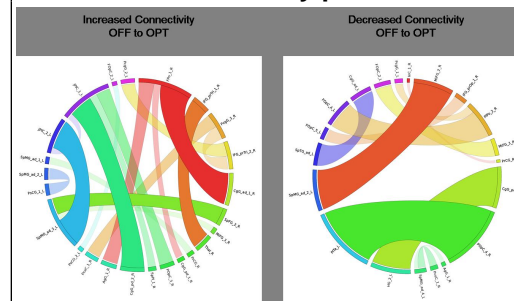
## correlation plots

### Average Correlation Plots



change in correlation with off and optimum settings

## connectivity plots



## Results

There were no adverse effects with SCS and fMRI. Significant differences in resting state brain connectivity were seen between several regions related to pain perception, including the left frontal insula, right primary and secondary somatosensory cortices, as well as in regions involved in the default mode network (DMN). Therapeutic SCS resulted in decreased connection strength between somatosensory and limbic areas and increased connection strength between somatosensory and default mode network.

## Conclusions

fMRI can be safely performed with SCS. Pain relief from SCS reduces the connectivity between the somatosensory and limbic/affective regions as compared to baseline. This suggests that optimal spinal cord stimulation may be reducing negative emotional processing associated with pain, allowing somatosensory areas to become more integrated into default mode activity and normalization of brain networks.

## Learning Objectives

- 1) Learn the neurophysiological basis and cortical processing of sensory information following spinal cord stimulator implantation surgery in patients with chronic pain syndromes.
- 2) Understand the sensitivity of rfMRI in detecting changes in the functional cortical connections related to the SCS settings.
- 3) Understand various methodologies to acquire rfMRI data to unveil functional cortical connections in SCS settings.