Psychotherapy changes our ways of thinking, feeling, and behaving; and can also change our perception of pain. Using functional Magnetic Resonance Imaging (fMRI), our lab has previously demonstrated that there are differences in neural function between the brains of healthy volunteers and chronic pain patients, and that these functional differences are attenuated after as few as three months of Cognitive Behavioral Therapy (CBT). Further, there was a statistically significant increase in cortical thickness after therapy (Naylor et al., in preparation for publication). The goal of the present study is to investigate whether white matter also changes as a result of clinical intervention. It is our hypothesis that the observed structural and functional changes will correlate with corresponding changes in white matter. Specifically, we expect to see increased fractional anisotropy in tracts connecting brain regions that show structural and functional changes after CBT, as measured by Diffusion Tensor Magnetic Resonance Imaging (DT-MRI, or DTI).

The Effects of Cognitive Behavioral Therapy on White Matter In the Human Brain, as Measured by DT-MRI

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Subjects: 9 female chronic pain patients. Each patient received fMRI scans prior to and after the completion of eleven weeks of cognitive behavioral therapy geared toward coping with pain.

Imaging: Patients were scanned with a 3T Philips Achieva TX high field MRI scanner. DTI was acquired via an axial 2D spin echo EPI sequence with 6 diffusion directions, using the following parameters: 30 slices with slice thickness = 5mm, TR = 5400ms, TE = 66ms, in-plane resolution = 2x2mm, b-value = 1000 s/mm2, EPI factor = 45.

Data analysis: Data was analyzed using PRIDE V4.1 Fiber Tracking 6.5 (Philips Healthcare) on the IDL Virtual Machine (RSI/ITV Visual Information Solutions). Statistics were performed using PASW Statistics 18.

Methods

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Results

Preliminary analysis of our data reveals a statistically significant increase in fractional anisotropy within the right anterior cingulum bundle (95% CI, t = -3.994, p = 0.007; two-tailed, paired samples t-test) between pre-CBT and post-CBT scans. We have also observed significant differences in apparent diffusion coefficients (ADC) in the left cingulum (t = -2.795, p = 0.023), the anterior arm of the left internal capsule (t = -3.010, p = 0.017), and the posterior arm of the left internal capsule (t = -2.795, p = 0.023) in post-CBT scans as compared to pre-CBT.

Discussion

Analysis of our results is still in the preliminary stages. However, we consider the observed difference in FA to be important because:

- The fibers of the anterior cingulum bundle originate within the anterior cingulate gyrus, a brain region known to play a role in attention, motivation, emotion and sensation of pain.
- The cingulate gyrus receives input from thalamic nuclei and assorted neocortical regions, and then projects to limbic areas including the central and basolateral amygdala and the insular cortex.

This result suggests that CBT influences not only gray matter structure and function but may also influence white matter connectivity in the brains of patients with chronic musculoskeletal pain.

We are in process of interpreting the differences in ADC in the left cingulum and left internal capsule. Future plans are to compare these changes with structural and functional data currently being generated in our lab. We will implement FSL analysis tools to examine group FA means and to allow visualization of smaller fiber tracts that we have not been able to isolate using PRIDE Fiber Tracking.

References


Acknowledgements

This study supported by the UVM MRI Center for Biomedical Imaging and US Dept. of Energy grant SC0001753. Acknowledgements: Elizabeth McCaflon, Lori Turner, Jay Gonyea, Scott Hipko, Shelly Naud.