Brain white matter structural properties predict transition to chronic pain

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INTRODUCTION

- Neural mechanisms mediating the transition from acute to chronic pain remain largely unknown.
- In a longitudinal brain imaging study we followed over a one-year period subjects with a single episode of sub-acute back pain (SBP) as they either recovered (SBPr) or persisted into chronicity (SBPp).
- We previously showed that in SBPp there are region specific decreases in grey matter density, and increased functional connectivity that robustly predicts pain chronification (Baliki et al., 2012).
- Here we examine white matter properties, regarding integrity and structural connectivity between SBP groups, and relative to chronic back pain and healthy controls.

METHODS

- T1 and DTI data was acquired with a 3T Siemens Trio whole-body scanner on 28 healthy subjects (37.7±1.5 yrs; 12F, 24 CBP (46±1.6 yrs; 11F) and 46 SBP (42.7±1.5 yrs; 22F) who had back pain for between 4-16 wks.
- All subjects were scanned 2 weeks after recruitment. They were scanned again 6 weeks, 6 months and 1 year later.
- We arbitrarily divide the SBP cohort into two subgroups: discovery (N=24) and Validation (N=22).
- All Data was analyzed with FSL v4.1.8.
- Voxel-wise statistical analysis of FA data was carried out using the tract-based spatial statistics (TBSS) for the discovery group.
- FA differences between SBPp and SBPr were identified (grp-FA) and reproduced in Validation group.
- Grey-white matter interface was identified using Sienax (part of FSL).
- Probabilistic tractography was conducted using Probractx (part of FSL).

RESULTS

1) Regional FA differences at baseline distinguish SBPp from SBPr.

2) Regional FA differences at baseline predict SBP groups one year later in a new cohort of patients.

3) Diffusivity properties for white matter tracts where FA was decreased in SBPr.

4) Identifying Grey-white matter interface for medial and lateral frontal cortices.

5) SBP groups exhibit Differential structural connectivity to medial and lateral prefrontal cortices.

6) mPFC-NAc functional connectivity is differentially related to FA.

CONCLUSION

- We demonstrate an accurate, and validated, prediction of pain chronification based on white matter structural differences at baseline.
- As FA values were constant over one year, and SBP group FA corresponded with healthy and CBP groups, we conclude Invariant structural properties as measured by FA predispose subjects to pain chronification.
- Present results and earlier observations (Baliki et al. 2012) suggest the sequence of brain reorganization with pain chronification: Subjects vulnerable to chronic pain, due to white matter properties, develop heightened emotional-learning response after peripheral injury, which in turn reorganizes cortical grey matter and functional connectivity into a chronic pain state.

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