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To cite this version:

Julie Coloigner, Jean-Marie Batail, Isabelle Corouge, Dominique Drapier, Christian Barillot. White matter connectivity analysis in patients suffering from depression.. 2018 - 7ème Forum de l’Institut de Psychiatrie, Sep 2018, Amiens, France. pp.1. hal-01890087

HAL Id: hal-01890087
https://hal.archives-ouvertes.fr/hal-01890087
Submitted on 8 Oct 2018

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White matter connectivity analysis in patients suffering from depression

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Introduction

- Major depressive disorder (MDD) is characterized by a profound dysregulation of affect and mood: cognitive dysfunction, insomnia, fatigue and appetite disturbance.
- Up to 80% of patients will suffer from a relapse.
- Understanding the neural correlates underlying the depression is critical for improving the efficacy of diagnostic and treatment strategies.
- Dysfunction of the circuits connecting frontal and subcortical brain regions, leads to a "disconnection syndrome" \cite{Liao2013}.
- Using graph theory-based analysis, we examined white matter changes in the organization of networks in patients suffering from depression.

Material and Methods

Data:
- LONGIDEP is a routine care cohort of patients suffering from MDD who underwent clinical, neuropsychological testing and imaging study.
- DTI scans: 30 directions using an EPI sequence with a b-value of 1000s/mm\textsuperscript{2}.
- 20 MDD patients and 20 healthy controls (CTL) subjects.

Network node definition:
- Parcellation of the cerebral cortex into 66 cortical and 14 subcortical regions using Freesurfer image analysis \cite{Fischl2002}.
- Each regions represents a node of the cortical network

Diffusion tractography:

Network analysis:
- Computation of various metrics that characterize the global organization of anatomical networks.
- Fiber density (number of fibers normalized by ROI volume) characterizes the strength of inter-regional connections.
- Regional nodal properties: Strength (reflects how the node is interacting with many other nodes in the network), Betweenness (in integrating dispersed networks) and Clustering (in local networks).
- Two-sample Student t-test between the two groups with age, gender, duration of disease and medication load \cite{Sackheim2001} as nuisance covariates, combined with a permutation test.

Results

- Widespread white matter abnormalities in patients with MDD: reduced connection between the frontal and parietal lobes, and between the frontal pole and limbic regions.
- In the frontal pole: reduced strength and reduced clustering.
- Higher betweenness in right and left thalamus and in right putamen for MDD.

Conclusion

- Decreased fiber density in circuits connecting subcortical brain regions with the frontal and parietal cortex, supporting the theory of limbic-frontal circuit dysfunction in MDD.
- Less segregated network organization in the frontal lobe, implicated in abnormalities of emotion regulation and cognition in MDD.
- Thalami and putamen: highly interactive regions that likely participate in more functional interactions.

\cite{Liao2013, Wiest2015, Sackheim2001}