The Global ECT-MRI Research Collaboration and initial results from a common processing pipeline

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Introduction

Major depression (MD) is a leading cause of disability worldwide. Electroconvulsive Therapy (ECT) is an effective treatment option in otherwise treatment-resistant patients.

Several studies have shown that ECT induces volumetric brain changes, particularly in the anterior medial parts of the temporal lobe. However, sample size often limits generalizability in single studies.

Our goal is to form a Global collaboration for longitudinal investigations of ECT that utilizes Magnetic Resonance Imaging (GEMRIC) and to perform retrospective mega-analyses of structural multi-site data. Such studies require procedures to handle or reduce variance posed by site-specific research protocols, e.g. differences in imaging acquisition parameters and scanner systems.

Here we evaluate if the variance of imaging biomarkers can be reduced by correcting images for scanner specific gradient field non-linearities.

Methods

a) A systematic search in Medline, Embase and PsyInfo was undertaken to identify studies that included radiological measurements before and after ECT.

b) Regular conference calls and workshops to establish protocols for subject inclusion, document and quantify site differences in ECT treatment and allow for sharing of raw data for retrospective analysis.

c) A processing pipeline for automated longitudinal analysis of multi-site data is being set up on a common analysis platform to limit differences induced by software installations; Data Portal (Bartsch, Thompson et al. 2014). We compare data before and after correction for scanner specific gradient field non-linearities (Jovicich, Czanner et al. 2006) by manual and automated analysis (FreeSurfer) from two different 3T scanners from one of the participating sites. Significance was assessed by paired t-tests.

Table 1. Table 1. Left; combined sample size for all current sites in GEMRIC. Middle; scanner type and field strengths across all sites. Right; multi-parametric MRI, sequences across scanners and sites.

Results

a) The search identified 2153 papers of which 94 included radiological measurements before and after ECT.

b) Of 94 studies, 14 included volumetric T1 acquisitions, and the 11 corresponding authors of these papers were contacted by email in November 2014. Currently 12 groups, all with multi-parametric MRI protocols (Table 1) participate in the collaboration. The combined number of patients and controls is ~300 and ~200, respectively.

c) Results from 2 scanners (n=6 on each scanner, 2 time points each) indicate reduced variability after implementing the correction procedure. The effect of distortion correction (Fig 1; single subject; scanner 1) was largest towards the apex of the skull where the manually measured dura-dura distance changed by ~8% (p<0.003) and 2% (p=0.005) for scanner 1 and 2, respectively. The calculated ECT induced hippocampal volume change, based on automated FreeSurfer analysis, before and after correction was (absolute value in μl ± SD, n=12) 254 ± 304 (p=0.01) and 339 ± 232 (p=0.0004), representing a relative change of 3.4 and 4.7%, respectively. The change in variance can also be appreciated in Fig 2A. While ECT induced hippocampal volume change was expected, the estimated intracranial volume was not changed after treatment; the relative change (in %) was 0.6 (p=0.3) and 0.5 (p=0.2), respectively. However the variance also in this measure seemed somewhat reduced after correction with a SD (in μl) of 26921 and 17838 before and after correction, respectively (Fig 2B).

Conclusions

1. A systematic approach was applied to form GEMRIC, a collaboration with a current combined data pool >5x that of any single participating study.

2. Correcting multi-site data for scanner specific distortions reduces the variance in volume measures, which increases the detectable effect size of structural ECT-induced volumetric changes.

3. The large combined sample size will allow implementing new voxel-based morphometry methods. After common processing, all data will be available for the collaboration and allow for replication of findings as well as testing of new hypotheses with larger power than prior studies.

References


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