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

Leif Oltedal[1], Hauke Bartsch[2], Ole Johan Evjenth Sørhaug[1], Ute Kessler[3], Lars Ersland[4], Christopher Abbott[5], Bogdan Draganski[6], Indira Tendolkar[7], Pia Nordanskog[8], Martin Jorgensen[9], Annemieke Dols[10], Wendy Nieuwdorp[11], Louise Emsell[12], Miklos Argyelan[13], Amit Anand[14], Katherine Narr[15], Anders M. Dale[2] and Ketil J. Oedegaard[1]

[1]Department of Clinical Medicine, University of Bergen, Bergen, Norway, [2]Multi-Modal Imaging Laboratory, Department of Radiology, University of California, San Diego, United States, [3]Division of Psychiatry, Haukeland University Hospital, Bergen, Norway, [4]Department of Clinical Engineering, Haukeland University Hospital, Bergen, Norway, [5]Department of Psychiatry, University of New Mexico School of Medicine, Albuquerque, United States, [6]Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland, [7]Donders Institute for Brain, Cognition and Behavior, Nijmegen, Netherlands, [8]Department of Medical and Health Science, University of Linköping, Linköping, Sweden, [9]Psychiatric Center Copenhagen, Copenhagen, Denmark, [10]VUmc Amsterdam/GGZinGeest, Amsterdam, Netherlands, [11]University Medical Centre, Utrecht, Utrecht, Netherlands, [12]Department of Imaging and Pathology, University Hospitals Leuven, Leuven, Belgium, [13]Center for Psychiatric Neuroscience at the Feinstein Institute for Medical Research, New York, NY, [14]Cleveland Clinic, Center for Behavioral Health, Cleveland, United States, [15]UCLA Brain Research Institute, Los Angeles, CA

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 PsycInfo 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.

Sample (all sites combined)		Scanner types and field strengths					MRI (sites per modality)						
	Completed (n)	Target (n)	Field (Tesla)	Siemens	GE	Phillips	T1	T2 /FLAIR	DWI	Rest fMRI	Task fMRI	SWI	MRS
Patients	299	449	1.5	2									
Controls	169	168	3.0	5	4	2	12	6	9	9	3	3	5
			7.0			1							

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.
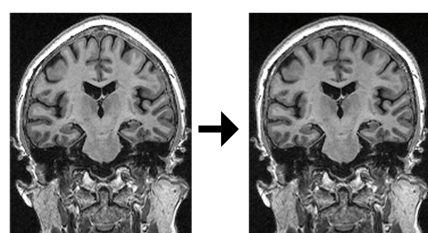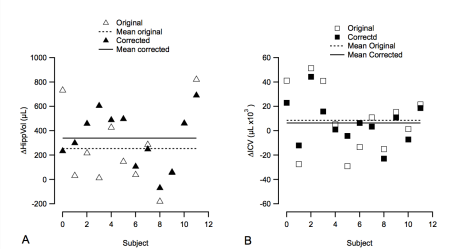

Fig. 1. Coronal images before (uncorrected) and after (corrected) image processing with algorithm that corrects for gradient non-linearities.

Fig. 2. Figure 2. A) Change in hippocampal volume after ended treatment series. Notice increased mean effect size and reduced variance after distortion correction. B) Total intracranial volume measured before and after treatment. There was no statistically significant change. Notice a tendency to reduced variance after corrections.

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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Correspondance: Leif Oltedal[1]; leif.oltedal@uib.no