White matter track integrity is not impaired by electroconvulsive therapy

E. B. Beall[1], K. E. Sakaie[1], S. Szymkowicz[2], D. J. Muzina[3], R. M. Dale[2], D. A. Malone[2], M. D. Phillips[1], and M. J. Lowe[1]
[1]Imaging Institute, Cleveland Clinic, Cleveland, OH, United States, [2]Psychiatry and Psychology, Cleveland Clinic, Cleveland, OH, United States, [3]Medco Neuroscience Therapeutic Resource Center, Fort Worth, TX, United States

Introduction:

Electroconvulsive therapy (ECT) is a safe and effective treatment for major depression often reserved for patients who are either unresponsive to or intolerant of pharmacologic therapies. Controlled trials have consistently found ECT to be equal or superior to antidepressant medication treatment [1]. However, without maintenance ECT, half of treated patients relapse by 6 months [2]. Acute ECT consists of a series of induced seizures, and presents an opportunity for a controlled study of white matter track integrity following ECT. The consensus reached from past studies of white matter MR imaging of ECT has been that white matter track integrity measures are unaffected by ECT. However, none of these past studies have been performed using pre- and post-ECT imaging of the same subjects, and none have used probabilistic fiber tracking to more accurately delineate the pathways of interest. Here we present results from a controlled study of pre- and post-ECT white matter track integrity measured using fractional anisotropy (FA) and transverse diffusivity (TD) from an initial sample of 7 ECT patients with treatment-resistant depression.

Methods:

Seven patients with treatment-resistant depression were recruited by the treating physician after being identified as candidates for an initial series of ECT. Subjects were scanned in an IRB-approved protocol at 3T in a 12-ch receive head coil. Subjects were scanned within a week before their first ECT session (pre-ECT imaging) and between one and three weeks following their final ECT session (post-ECT imaging). Diffusion Tensor Imaging (DTI) scans in two subjects were unusable due to motion and scanner artifact. A T1-weighted anatomic MPRAGE and 2 DTI scans were acquired at each session. DTI parameters were: 51 2mm thick axial slices acquired with 71 non-collinear diffusion weighting gradients, b=1000 sec/mm2, and seven b=0 images interleaved evenly throughout the scan; TE/TR=78/7700 ms, 128x128 matrix, 256x256mm FOV, 5/8 partial Fourier, BW=1628Hz/pixel. A fiber orientation distribution (FOD) is determined by fitting the diffusion profiles[3]. A white matter mask is created using the T1 anatomic and coregistered to the mean b=0.

Probabilistic tracking is performed between pairs of seeds to determine white matter pathways [3,4]. The FA, TD and MD images are masked to the white matter mask and these tracks and averaged values created for each pathway, for each subject [7]. This is done by dividing the sum of track density weighted diffusivity values by the sum of track density for the pathway. The pathway of interest was the fronto-parietal pathway (see lower half of Fig 2 for track density overlain on mean b=0 image). This pathway was defined by anatomic ROIs guided by coregistered functional activation to a spatial working memory task [5].

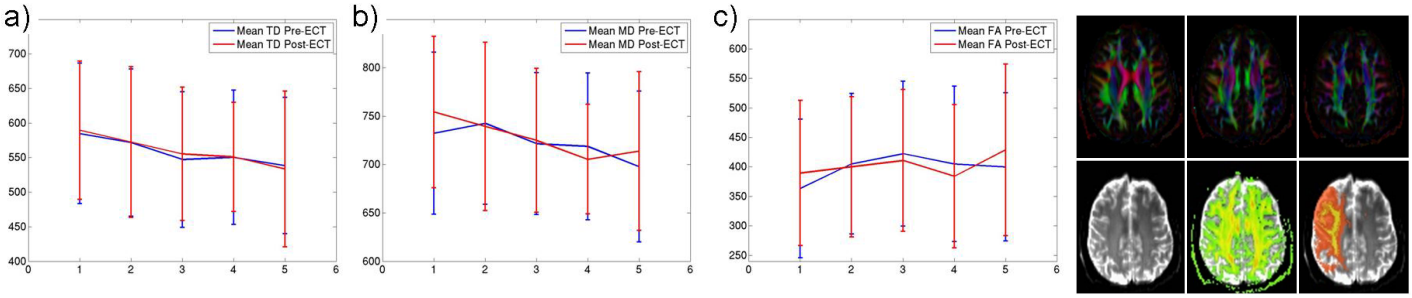

Fig 1 shows mean a) TD, b) MD, and c) FA values in each of five subjects (error bars are standard deviations, note these are not normal distributions). Fig 2 shows representative colorized FA maps on top, and colorized FA maps on top row, mean b=0 on bottom row with FA and fronto-parietal track density map overlain.

Results and Discussion:

The mean FA, TD and MD had no consistent change from pre- to post-ECT scanning, and variability between subjects was greater than any individual apparent change from pre- to post-ECT. This is the first ever controlled pre/post probabilistic fiber tracking study of ECT and these results support past findings of white matter track integrity unaffected by recent acute series of ECT treatment.

References:

1) Pagnin et al, J ECT 2004;20:13–20. 2) Prudic et al, Am J Psychiatry, 1996;153:p985-92. 3) Sakaie et al, Neuroimage 2007; 34:p169-176. 4) Lowe et al, Human Brain Mapp 2008;29:p818-827, 5) Beall et al, ISMRM 2010