Transverse Relaxation Changes in Tourette Syndrome

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INTRODUCTION:

Tourette Syndrome (TS) is a chronic neuropsychiatric disorder characterized by involuntary motor and vocal tics. Functional and volumetric neuroimaging studies of TS have implicated circuits connecting the cortex, striatum, and thalamus (CSTC circuits) in the pathophysiology of the disorder. Previous imaging studies[1] have shown transverse relaxation time (T2) to be an indicator of brain water content and iron concentration. Only one study has examined T2 abnormalities in TS, with Peterson[2] noting T2 asymmetries in the insula and frontal white matter in adult patients, which may have reflected abnormal asymmetry of tissue composition and/or water content. There were also trends to abnormal asymmetries in the caudate nucleus and putamen. The objective of this study was to investigate T2 relaxation times in a group of male children and adolescents with Tourette syndrome. We hypothesized that patients would have an abnormal pattern of T2 asymmetry in CSTC structures compared to controls.

METHODS:

Eleven male patients with Tourette Syndrome (age: 10.8±2.7 years) and nineteen male controls (age: 10.6±2.9 years) underwent a magnetic resonance imaging study. All subjects had a full-scale intelligence greater than 70, and any subject with a history of a seizure disorder was excluded. The two groups did not differ significantly in terms of age, sex, race, handedness, or intelligence. Three patients were medication-naïve at the time of their scan, while one other patient had discontinued psychotropic medication they had been taking previously. The other patients were being treated with stimulants (n=2), antipsychotics (n=5), and antidepressants (n=1). Nine patients required sedation to complete the scan, using either oral midazolam (n=4) or chloral hydrate (n=5). Nine patients had comorbid attention-deficit/hyperactivity disorder. This study was approved by the local Health Sciences Research Ethics Board.

Imaging experiments were performed with a 3.0 T head-only research scanner (IMRIS, Winnipeg, Canada) with a quadrature head coil. Magnetic resonance images were acquired using a **G**radient-**E**cho **S**ampling of the **F**ree **I**nduction **D**ecay and **E**cho (GESFIDE[3]) sequence. Imaging parameters included a 192 x 256 matrix size, FOV = 220 mm, bandwidth = 50kHz , 4 mm slice thickness, slice spacing =6mm, TR = 2500 msec and a total imaging time of 8 minutes. For our study, five gradient echoes were acquired prior to the 180º radio frequency (rf) pulse, with a first-echo time of 9 msec and an inter-echo spacing of 8.70 msec. Six gradient echoes were acquired after the 180º rf, each spaced by 8.78 msec. The k-space data was then reconstructed into $R2^*$ and $R2^-$ maps by performing a voxel-by-voxel least-squares fit of the natural logarithm of the signal amplitude versus echo time. R2 maps were calculated from $R2 = (R2^* + R2^-)/2$.

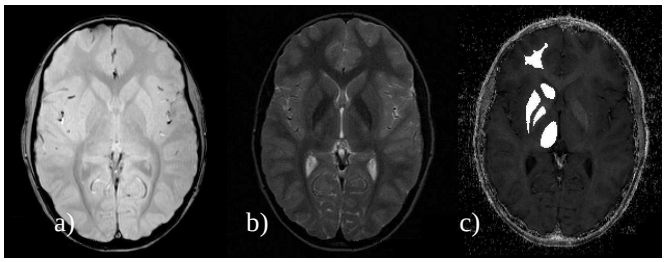

Figure 1. (a) Proton density weighted image (b) T2 weighted image and (c) 1/T2 map of an adolescent brain

T2 from the basal ganglia (caudate nucleus, putamen, globus pallidus), thalamus, and frontal white matter was analyzed using a slice parallel to the imaginary line joining the anterior and posterior commissures. Specified brain structures were determined from the T2 weighted and proton-density weighted images allowing accurate representation of the regions of interest (ROI). The ROI tracing and mean R2 value calculation was performed with EIGENTOOL software[4]. Group differences in mean T2 relaxation times were examined using a repeated measures analysis of variance. An index of asymmetry ([right-left]/[right+left]) was calculated for each region and compared between the groups using one-way analysis of variance.

RESULTS:

A significant group by side interaction was detected [F=5.4, df=1,25, p=0.03]. Post-hoc analysis revealed a significant group difference in the frontal white matter index of asymmetry, with patients having a reversed pattern of asymmetry [F=5.0, df=1,29, p=0.03]. No other differences in asymmetry were found.

DISCUSSION:

Patients with Tourette Syndrome had abnormal patterns of T2 relaxation time asymmetry in frontal white matter, but no other differences were found. The findings of this study need to be interpreted cautiously in light of several limitations (small sample size, lack of female subjects, possible medication effects), but they suggest abnormalities of asymmetry of frontal white matter composition in children and adolescents with Tourette Syndrome. These findings are in keeping with the only previous study of T2 in Tourette syndrome, although other abnormalities of T2 found in adult patients in that study were not detected here.

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