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Preliminary investigation of the impulsive and neuroanatomical characteristics of compulsive sexual behavior

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A B S T R A C T

In recent years, there has been increased interest in a clinical syndrome characterized by excessive sexual thoughts, sexual urges, and/or sexual behaviors that has many aspects in common with impulse control disorders. This study provides a preliminary examination of the impulsive aspects of this syndrome, compulsive sexual behavior (CSB). Sixteen male subjects, eight CSB patients and eight non-patient controls, completed psychometric measures of impulsivity and compulsive sexual behavior, performed a behavioral task designed to assess impulse control (Go–No Go task), and underwent diffusion tensor imaging (DTI) procedures. The results indicated that CSB patients were significantly more impulsive; whether measured by psychometric testing or the Go-No Go procedure, than controls. The results also indicate that CSB patients showed significantly higher superior frontal region mean diffusivity (MD) than controls. A correlational analysis indicated significant associations between impulsivity measures and inferior frontal region fractional anisotropy (FA) and MD, but no associations with superior frontal region measures. Similar analyses indicated a significant negative association between superior frontal lobe MD and the Compulsive Sexual Behavior Inventory. Thus, while CSB patients were more impulsive than controls, the DTI results were not consistent with impulse control disorders.

1. Introduction

Over the course of the last several decades, an increasing number of clinicians and researchers have become interested in a clinical syndrome involving excessive sexual thoughts, sexual urges, or sexual activity which cause distress or impairment. This phenomenon has been called compulsive sexual behavior (CSB; Quadland, 1985; Coleman, 1991), paraphilia-related disorder (Kafka, 1994), sexual impulsivity (Barth and Kinder, 1987), and sexual addiction (Carnes, 1983; Goodman, 1993). Coleman and colleagues (Coleman et al., 2000) proposed criteria for CSB that require the presence of recurrent and intense sexually arousing fantasies, sexual urges, or behaviors over a period of at least 6 months that cause distress or impairment. While there are some disagreements over the nature and the etiology of compulsive sexual behavior, all of the researchers listed above agree that the syndrome includes intense, intrusive sexual urges and fantasies, along with excessive problematic sexual behavior. In this manner, CSB resembles impulse control disorders such as kleptomania, pathological gambling, and eating disorders such as bulimia nervosa and binge eating disorder.

Although there have been no brain-imaging studies of CSB, it has been suggested that damage to the frontal lobes can result in disinhibition of sexual behavior, and thus, hypersexual, or CSB (Coleman, 2005). Diffusion tensor imaging (DTI) is an MRI technique that measures the self-diffusion of water in brain tissue. DTI has been used to provide quantitative information about white matter organization and integrity. The DTI data can be represented in a number of ways, including fractional anisotropy (FA), a measure of the extent to which water diffusion is directionally restricted, and mean diffusivity (MD), a measure of overall diffusivity in the tissue. Grant et al. (2006) used DTI to examine white matter in kleptomania. These investigators found that FA was significantly lower in the inferior frontal regions of individuals with kleptomania, indicating altered white matter organization in this region of the brain, which influences executive function and inhibitory control (Hoptman et al., 2002).

The purpose of this study is to explore white matter micro-structure with DTI in men with CSB. Given the results for kleptomania and the presence of impulsivity in CSB, we hypothesized that we would find greater disorganization of white matter on DTI in the frontal lobes of men with CSB and that this white matter disorganization would be

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associated with greater impulsivity in CSB patients than non-CSB controls.

2. Methods

2.1. Subjects

Eight men who met the proposed research criteria for CSB described above were recruited from a treatment program for individuals seeking treatment for sexual problems. CSB patients all reported non-paraphilic CSB. Five of the eight (62%) had a history of major depression, almost all (7 of 8) had a history of alcohol abuse or dependence, and four (50%) had a history of other substance abuse or dependence. One subject had a history of obsessive–compulsive disorder, and another subject reported current social phobia. Eight male age-matched controls were selected from a database of healthy individuals who were willing to participate in imaging research studies. The mean ages of the CSB and control groups were 44.5 ± 10.6 years and 43.4 ± 9.1 years, respectively. Subjects ranged in age from 19 to 51 years and were not significantly different. All of the CSB participants were Caucasian and all but one of the control participants were Caucasian. Participants were most likely to have at least some college education (100% of CSB group and 75% of control group) and to hold technical or professional jobs (86% of CSB group and 63% of control group). Neither the educational level nor the employment level variables were significantly different.

2.2. Procedures

All participants were screened to determine if they were eligible for and interested in participating in the study. Subsequently, an initial evaluation was scheduled. During this appointment all participants were interviewed using the Structured Clinical Interview for DSM-IV, Patient version (SCID-P: First et al., 1995), which had a section developed by our research group added to assess the symptoms of compulsive sexual behavior (Raymond et al., 1999). These interviews were used to determine if the participant met criteria for CSB and had no active major psychiatric illnesses or substance use disorder as these were conditions that would preclude participation in the study. Also, SCID results indicated no active co-morbid impulse control disorders in either CSB patients or controls.

During the initial appointment participants also completed several self-rating scales including: 1) the Compulsive Sexual Behavior Inventory (Coleman et al., 2001; Miner et al., 2007), a 22-item scale that assesses the severity of CSB symptoms, 2) the Barratt Impulsiveness Scale (BIS 11: Patton et al., 1995), a 30-item scale that measures severity of impulsive traits, and 3) the Multidimensional Personality Questionnaire (Patrick et al., 2002), a 166-item scale that assesses various personality characteristics including the Constraint factor (assessing a trait that is essentially the opposite of impulsivity so that low scores on this scale indicate greater impulsivity) and the Negative Emotionality factor (assessing a trait that involves difficulties with emotional regulation). A computerized Go-No Go continuous performance task (Braver et al., 2001) was also completed by all participants. The program required participants to either push or not push a button when they saw an "X" under two different conditions. During task 1, the target was presented frequently that is, respondents were instructed to push the left mouse button when they saw any letter other than an "X" (83% frequency) and inhibit pushing the button when an "X" appeared (17% frequency). This condition assesses the degree of impulsivity by computing errors of commission, when the participant fails to inhibit response by pushing the button in the presence of the letter X. In task 2, respondents push the left mouse button only when they see an "X" (17% frequency) and the object is to remain attentive so as not to miss pushing the button when a target (the letter X) appears. This task assesses inattentiveness by computing the errors of omission, when participant fails to respond by pressing the button in the presence of the letter X.

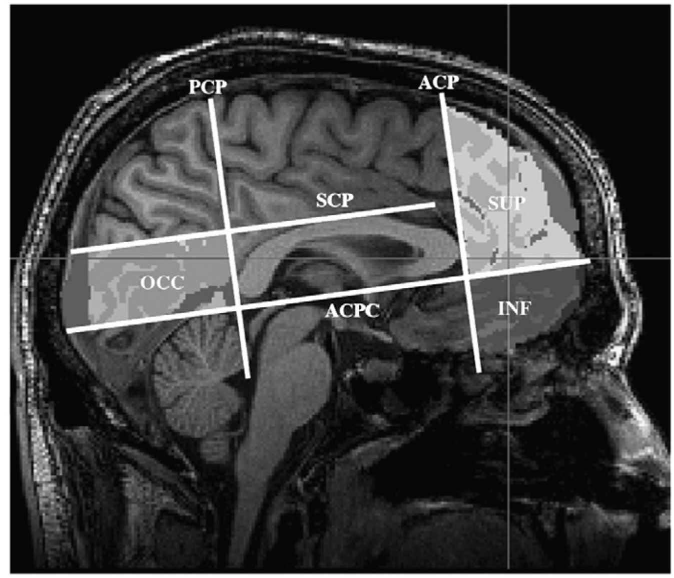

Fig. 1. Sagittal view: Frontal region defined as the anterior coronal plane (ACP) andsubdivided by the ACPC plane into the superior frontal (SUP) and inferior frontal (INF) regions.

2.2.1. Imaging parameters

At the second appointment magnetic resonance imaging data were acquired from all participants on a research-dedicated Siemens 3T Trio scanner (Erlangen, Germany). Whole brain volumetric images with T_1 and proton density (PD) contrasts were obtained for use in tissue classification. T_1 images were acquired with coronal orientation, using an MP-Rage sequence (TR = 2530 ms, TE = 3.65 ms, TI = 1100 ms, flip angle 7°, 240 partitions, 1 mm isotropic voxel). PD images were acquired in the axial orientation, using a hyper-echo, turbo spin echo sequence (TR = 8550 ms, TE = 14 ms, flip angle 120°, 80 contiguous slices, $1 \times 1 \times 2$ mm voxel). DTI volumes were acquired with axial orientation and aligned to the PD volume, using a double spin echo, single shot EPI acquisition with 12 diffusion gradient directions (TR = 11500 ms, TE = 98 ms, 64 contiguous 2-mm slices, 2-mm isotropic voxel, $b = 1000$ s/mm^2, 2 averages). A dual echo field map sequence with voxel parameters common to the DTI was acquired and used to correct the DTI data for geometric distortions caused by magnetic field inhomogeneities.

2.2.2. Anatomical processing

Image data was processed using software (BET, FLIRT, FAST, FDT, FUGUE) from the FMRIB Software Library (http://www.fmrib.ox.ac.uk/). The brain was first extracted from T_1 and PD images using BET. The T_1 brain was then aligned to the PD brain using FLIRT. Dual channel tissue classification was performed on the PD and aligned T_1 images using FAST, producing four tissue classes (CSF, white, gray, and blood).

2.2.3. DTI processing

The raw diffusion data were first corrected for eddy current distortion; then the diffusion tensor was computed using FDT, and the FA and MD maps were computed (Basser, 1995). The $b = 0$ diffusion volume and the FA and MD volumes were corrected for the distortion caused by magnetic field inhomogeneity using the field map image and FUGUE.

Subject-specific white matter masks were created on the dewarped DTI volumes by registering the partial volume estimate (PVE) white matter map from the dual channel FAST segmentation onto the distortion-corrected DTI image using the inverse of the