

A controlled positron emission tomography study of obsessive and neutral auditory stimulation in obsessive-compulsive disorder with checking rituals

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Abstract

Ten nondepressed patients with obsessive-compulsive disorder (OCD) who were characterized by predominant checking rituals were compared with 10 age- and sex-matched control subjects. Hemispheric and regional cerebral blood flow levels (rCBF) were measured with positron emission tomography ($H_2^{15}O$) across four conditions: rest, auditory stimulation with idiosyncratic normal or abnormal obsession, auditory stimulation with neutral verbal stimuli, and rest. Order of neutral and obsessive stimulation was randomized. Higher subjective responses to obsessive than to neutral stimulation were found in both groups; subjective response was higher in OCD patients when obsessive stimulation was presented first. A four-way analysis of variance (group \times stimulation order \times hemisphere \times condition [neutral or obsessive stimulation]) was performed on stimulation minus rest normalized rCBF values. Control subjects had significantly higher rCBF in the thalamus and putamen. A trend toward higher rCBF in OCD patients was found in the superior temporal regions. When neutral stimulation was presented first, rCBF was significantly higher in the caudate region of control subjects. Obsessive stimulation was associated with higher rCBF than neutral stimulation in orbitofrontal regions in both groups of subjects. Under obsessive stimulation, superior temporal and orbitofrontal activities were correlated in OCD patients but not in control subjects. Our study suggests specific abnormalities of information processing in the basal ganglia and temporal structures of compulsive checkers.

Keywords: Cerebral blood flow; Functional neuroanatomy; Anxiety disorder; Information processing; Obsessions; Compulsions

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1. Introduction

A number of positron emission tomography (PET) studies have found hypermetabolism in basal ganglia and/or orbitofrontal gyri of patients with obsessive-compulsive disorder (OCD) who were scanned in a resting state (Baxter et al., 1987, 1988, 1992; Nordahl et al., 1989; Swedo et al., 1989; Benkelfat et al., 1990; Sawle et al., 1991). Right caudate hypermetabolism was decreased by successful fluoxetine treatment or behavior therapy (Baxter et al., 1992). Serotonergic antidepressants decreased metabolism in orbitofrontal regions of interest (ROIs) and left caudate nucleus (Swedo et al., 1989; Benkelfat et al., 1990). In a study with ^{18}F fluorodeoxyglucose (^{18}FDG), Perani et al. (1995) found higher metabolism in the thalamus, cingulate cortex, and putamen/pallidum in baseline studies of OCD patients; treatment with serotonin reuptake inhibitors was associated with decreased metabolism in these areas. In an ^{11}C glucose study, Mindus et al. (1989) observed lower metabolism in the left orbital gyrus of five patients before capsulotomy; after capsulotomy, metabolism in orbital gyri and caudate nuclei was decreased. Martinot et al. (1990), in a study with ^{18}FDG , observed decreased metabolism in whole brain and prefrontal cortex; however, 10 of the 16 patients were receiving medication, which may explain the findings of hypometabolism. Single photon emission computed tomography (SPECT) studies (Machlin et al., 1991; Rubin et al., 1992; Harris et al., 1994) have demonstrated higher perfusion in OCD in frontal structures. In another SPECT study, OCD symptoms provoked by meta-chlorophenylpiperazine were related to hyperfrontality (Hollander et al., 1991). In sum, despite conflicting results, the most replicable finding of brain-imaging studies in OCD has been hyperfrontality as a state marker that can be modified by therapeutic interventions.

Stimulation effects were studied with SPECT (Zohar et al., 1989) in 10 OCD patients with contamination ideas and washing rituals. Three conditions were compared: relaxation, exposure in imagination, and exposure in vivo to 'contaminants'. There was a decrease of regional cerebral blood flow (rCBF) in parieto-occipital regions

during in vivo exposure, and an increase in the temporal region during exposure in imagination. A H_2^{15}O PET study (Rauch et al., 1994) compared innocuous with obsessive stimuli in a group of two checkers and six cleaner-washers, and found a bilateral obsessive stimulation effect in orbitofrontal cortex, right caudate nucleus, and left anterior cingulate. Another H_2^{15}O PET study (McGuire et al., 1994) in four patients with washing rituals who underwent 12 scans demonstrated a positive correlation between symptoms and blood flow in the right inferior frontal gyrus, caudate nucleus, putamen, globus pallidus, and thalamus, and the left hippocampus and posterior cingulate gyrus. There was also a negative correlation in the right superior frontal cortex and temporoparietal junction. These three studies did not have a control group. The present study assessed the effects of intrusive obsessive thoughts on rCBF in OCD patients with predominant checking rituals compared with effects in normal controls.

2. Methods

2.1. Rationale

Three surveys have shown that more than 80% of normal subjects have obsessive thoughts similar in content to those found in OCD patients (Rachman and De Silva, 1978; Salkovskis and Harrison, 1984; Freeston et al., 1991). 'Abnormal' and 'normal' intrusive thoughts do not differ in content but in rejectability, duration, frequency, and habituation. Although most normal subjects experience the same kind of intrusive thoughts experienced by OCD patients, they habituate quickly and are not compelled to ritualize.

Our study compared stimulation of OCD patients with their 'abnormal obsessions' and stimulation of control subjects with their 'normal obsessions'. The dependent variables were the subjective response to stimulation and rCBF in ROIs identified in previous studies of OCD. In an effort to have a homogeneous group of patients with specific cognitive disturbances, we included only predominant checkers in the study. Our hypothesis was that provocation by 'abnormal obsession' would modify rCBF in ROIs in OCD patients that

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