

Structural Differences in the Brains of Breast Cancer Patients Compared to Matched Controls Prior to Chemotherapy

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Abstract

Cognitive impairment has been observed in patients after they have undergone chemotherapy and this well documented phenomenon has been dubbed 'chemo-fog' or 'chemo-brain'⁷. Few studies have examined cognitive function prior to chemotherapy.^{1,7} The studies that have examined this subject have shown that, prior to treatment, breast cancer patients already begin to display signs of cognitive dysfunction. The underlying neurophysiological mechanisms of this dysfunction remains unknown. This study examines the underlying neural correlates of impairment before newly diagnosed patients undergo treatment.

Participants and Methods: 23 female breast cancer patients and 23 healthy controls had structural brain scans while in the MR scanner.

Results: Voxel-Based Morphometry revealed that there were no significant differences in grey matter among the two groups. Breast cancer patients had less white matter volume than controls in the following regions: left pre- and post-central gyrus, right inferior frontal operculum, left precuneus.

Conclusion: These findings reveal a decrease in white matter volume in breast cancer patients before they undergo treatment. These results suggest that other factors may contribute to the so called 'chemofog' effect.

Introduction

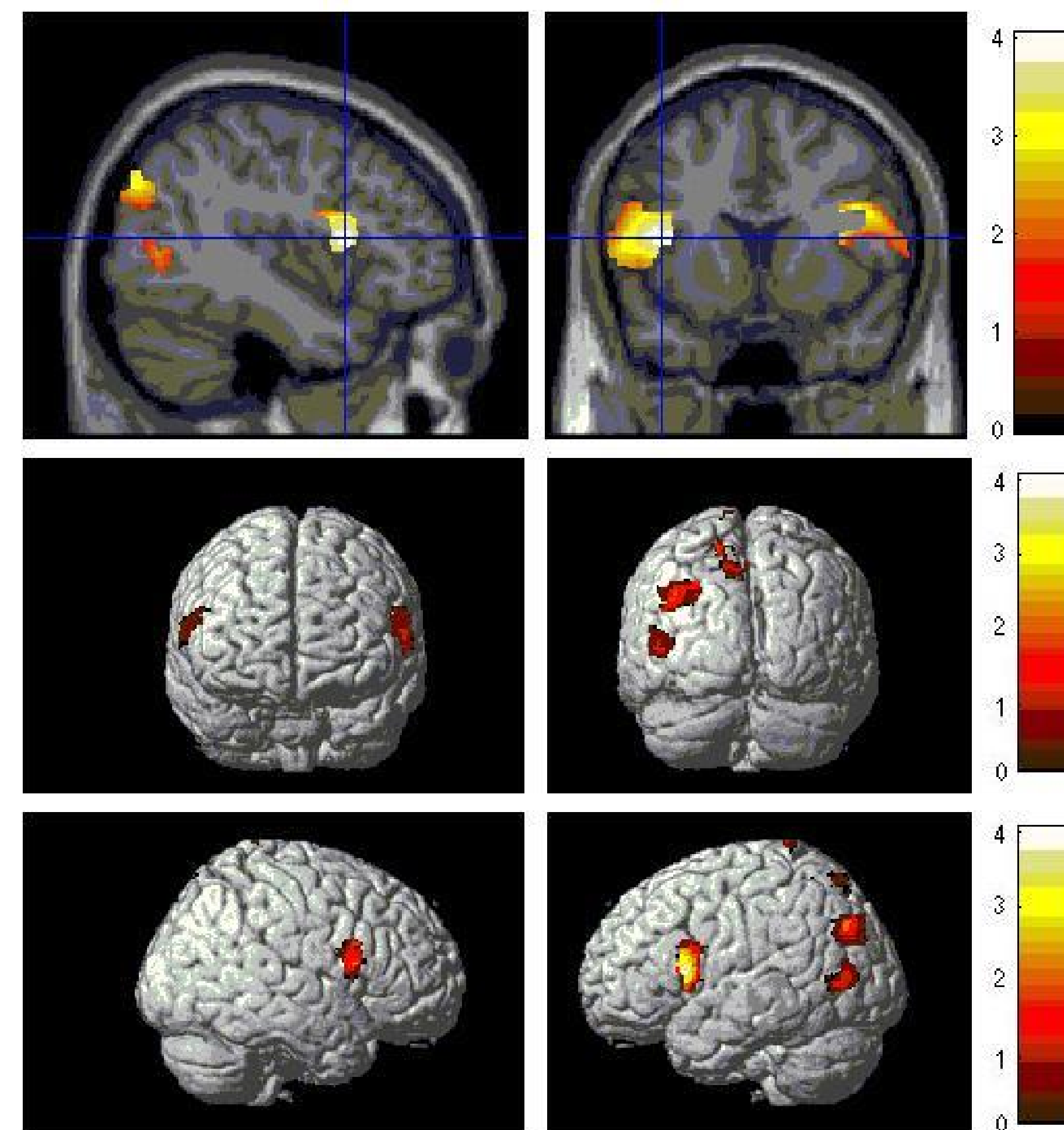
The study of the relationship between cognitive dysfunction and breast cancer has garnered much attention recently from the scientific community. Though the exact mechanism of the cognitive dysfunction is as-of-yet unknown, researchers have examined associated neural correlates using fMRI and have found that breast cancer patients having undergone chemotherapy have differing neural activations during memory encoding and recall in contrast to controls³.

Though there exists research demonstrating a deficit in cognitive tasks such as verbal learning and memory, abstract reasoning and motor coordination in breast cancer patients following chemotherapy³, recent studies have demonstrated that there are differences in cognitive functioning prior to chemotherapy between breast cancer patients and controls such that breast cancer patients perform more poorly¹.

These findings have led researchers to use neuroimaging techniques to investigate functional differences in breast cancer patients. Research as shown², that compared to healthy controls, breast cancer patients invoke greater neural pathways linked to attention/working memory when their selective attention and memory is tested and, further, that despite the great brain activity, breast cancer patients are less accurate and slower than healthy controls. These findings have highlight the need to investigate structural changes in breast cancer patients prior to chemotherapy in order to establish the neural correlates involved in the observed cognitive dysfunction in breast cancer patients.

The purpose of this study was to examine the brain structure differences between female early-stage breast cancer patients awaiting their first chemotherapy treatment and healthy controls. Specifically, to discover if there were differences in the volumes of white matter and grey matter between both groups.

Areas of Reduced White Matter in Pre-Chemotherapy Breast Cancer Patients



Method

Subjects

- 23 female, newly diagnosed Stage I or II breast cancer patients who had undergone either lumpectomy or mastectomy
- 23 female healthy controls
- Inclusion criteria: right handed, no metal implants, no corrective eye glasses, not claustrophobia, no diagnosed neurological or psychological disorder
- Patient group not diagnosed with previous cancer, received no previous treatment
- Control group not diagnosed with cancer
- Patients were recruited through the from the Ottawa Hospital Regional Cancer Centre
- Age range: 32-63
- Matched on age and education

Procedure

- Neuroimaging data was collected from each patient before they received chemotherapy treatment

Analyses

- Structural scans preprocessed using SPM 8 (Statistical Parametric Mapping 8)
- Converted from DICOM to nifti, then into segmented images, then smoothed
- Group differences analyzed using t-test in SPM8

Results

In line with previous research⁵, the results of the t-test revealed no significant differences in grey matter volume between the patients and healthy controls. There were statistically significant (FWE, $p = 0.00012$) differences in white matter volumes, however. Patients had less white matter volume in three distinct locations: 1) left pre- and post-central gyrus, 2) right inferior frontal operculum, and 3) left precuneus.

Discussion

These findings begin to offer insight into the relationship between cognitive impairment, neural structure, and breast cancer. For example, the right frontal operculum has been associated with episodic memory retrieval⁴, and its reduced volume in pre-chemotherapy patients may offer an avenue for future research in an attempt to further elucidate the association of cognitive impairment and breast cancer. These results also suggest that other factors may contribute to cognitive impairment seen in patients, such that the impairment observed in post-treatment may be the result of a carry-over effect.

Future studies should examine changes in neural structure and cognitive function in breast cancer patients in different intervals prior to, and subsequent to, chemotherapy.

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