Neural correlates of severe cognitive impairment and posttraumatic stress disorder: Preliminary analyses of World Trade Center responders

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Background

- World Trade Center (WTC) towers collapse in September 11, 2001, released more than a million tons of debris and dust, immersing responders in a toxic cloud[1] .

- WTC responders have also experienced traumatic exposures during search, rescue, and clean-up efforts[2].

Trauma   Toxic dust

- 20% developed posttraumatic stress disorder (PTSD)[3]
- 13% developed cognitive impairment (CI)[4]
- PTSD is increasingly recognized as a risk factor for CI and Alzheimer's disease and related dementias (ADRD).
- Little is known about mechanisms underlying this relationship between PTSD, CI and ADRD.

The goal of this study was to analyze neural correlates of PTSD and CI in WTC responders. This report provides preliminary results comparing anatomical connectivity between CI cases, PTSD cases, CI and PTSD cases, and controls.

Methods

Participants: 59 WTC responders

Characteristic	Total N=59	Control N=17	PTSD N=19	CI N=13	PTDS & CI N=10
Sex (% female)	17	0	16	31	30
Age (years (SD))	57 (5)	49 (3)	54 (4)	58 (6)	56 (6)
Exposure level (%): low; med; high	18; 75; 7	33; 60; 7	13; 80; 7	17; 66; 17	0; 100; 0

PTSD - posttraumatic stress disorder; CI - cognitive impairment; SD – standard deviation

Exposure level based on:
- The total time spent working at the WTC site
- Exposure to the cloud of debris from the collapse of the buildings
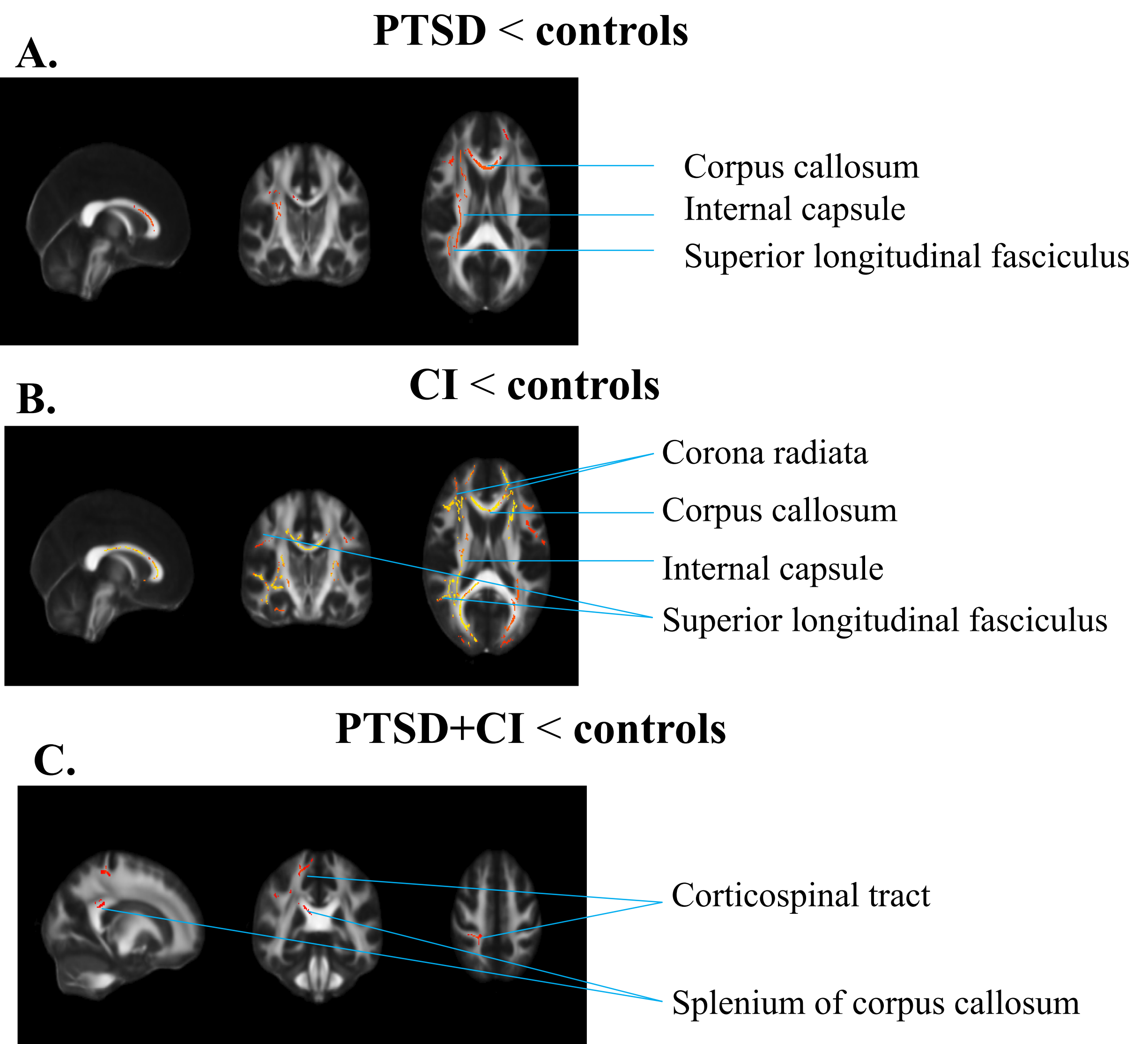- Work on the pile of debris

- **Image acquisition:** Diffusion-weighted imaging (DWI) MRI scan acquired on a Siemens 3T PET/MRI scanner.

- **Preprocessing:**
    - FMRIB's Software Library (FSL)- FMRIB's Diffusion Toolbox (FDT): head movement and eddy current correction, brain mask creation, fitting the diffusion tensor model
    - Tract-Based Spatial Statistics (TBSS) preprocessing: apply nonlinear registration of all FA images into a standard space, create the mean FA image and skeletonise it, project all subjects' FA data onto the mean FA skeleton

- **Statistical analysis:** whole brain voxel-wise group comparisons GLM of fractional anisotropy (FA) between each clinical group and the control group. All analyses were adjusted for age and sex, and are corrected for multiples comparisons.

Results

PTSD < controls

A.

- Corpus callosum
- Internal capsule
- Superior longitudinal fasciculus

CI < controls

B.

- Corona radiata
- Corpus callosum
- Internal capsule
- Superior longitudinal fasciculus

PTSD+CI < controls

C.

- Corticospinal tract
- Splenium of corpus callosum

p < 0.05 TFCE corrected for multiple comparisons

Figure 1. Whole brain voxel-wise group comparisons of fractional anisotropy (FA) in each clinical group vs the control group. (A) PTSD < controls (B) CI < controls (C) PTSD+CI < controls

Discussion

These preliminary results support anticipated trends overserved in the literature suggesting that CI may be associated with decreased FA in the corpus callosum and the left superior longitudinal fasciculus. Corpus callosum white matter abnormalities have also been previously reported in PTSD. Results in the PTSD+CI group show some overlaps with the ones seen in the PTSD only and CI only groups.

Clinical Relevance: These results are important for completing the long-term clinical picture of WTC exposure effects and have implications for brain aging.

References

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