Diffusion Tensor Imaging of Frontal White Matter and Executive Functioning in Cocaine-Exposed Children


Introduction

Although animal studies have demonstrated frontal white matter and behavioral changes resulting from prenatal cocaine exposure, no human studies have associated neuropsychological deficits in attention and inhibition with brain structure. We used diffusion tensor imaging to investigate frontal white matter integrity and executive functioning in cocaine-exposed children.

Experimental

Six direction diffusion tensor images were acquired using a Siemens 3T scanner with a spin-echo echo-planar imaging pulse sequence on right-handed cocaine-exposed ($n=28$) and sociodemographically similar non-exposed children ($n=25$) (mean age = 10.6 years) drawn from a prospective, longitudinal study. Average diffusion and fractional anisotropy were measured in the left and right frontal callosal and frontal projection fibers. Executive functioning was assessed using two well-validated neuropsychological tests (Stroop Color-Word Test and Trail Making Test).

Results and Discussion

Cocaine-exposed children showed significantly higher average diffusion in the left frontal callosal and right frontal projection fibers. Cocaine-exposed children were also significantly slower on a visual-motor set-shifting task with a trend toward lower scores on a verbal inhibition task. Controlling for gender and intelligence, average diffusion in the left frontal callosal fibers was related to prenatal exposure to alcohol and marijuana and an interaction between cocaine and marijuana exposure. Performance on the visual-motor set-shifting task was related to prenatal cocaine exposure and an interaction between cocaine and tobacco exposure. Significant correlations were found between test performance and fractional anisotropy in areas of the frontal white matter.

Conclusions

Prenatal cocaine exposure, alone and in combination with exposure to other drugs, is associated with slightly poorer executive functioning and subtle microstructural changes suggesting less mature development of frontal white matter pathways. The relative contribution of postnatal environmental factors, including characteristics of the caregiving environment and stressors associated with poverty and out-of-home placement, on brain development and behavioral functioning in polydrug-exposed children awaits further research.

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References