Nicotine & Tobacco Research Volume 10, Number 1 (January 2008) 137–147

informa
healthcare

Chronic cigarette smoking and the microstructural integrity of white matter in healthy adults: A diffusion tensor imaging study

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Received 17 October 2006; accepted 10 April 2007

Results from recent studies suggest that chronic cigarette smoking is associated with increased white matter volume in the brain as determined by in vivo neuroimaging. We used diffusion tensor imaging to examine the microstructural integrity of the white matter in 10 chronic smokers and 10 nonsmokers. All individuals were healthy, without histories of medical or psychiatric illness. Fractional anisotropy (FA) and trace were measured in the genu, body, and splenium of the corpus callosum. FA provides a measure of directional versus nondirectional water diffusion, whereas trace provides a measure of nondirectional water diffusion. Lower FA and higher trace values are considered to reflect less brain integrity. Voxel-based morphometry was used to define volumes in each of these regions of the corpus callosum. Chronic smokers exhibited significantly higher FA in the body and whole corpus callosum and a strong trend for higher FA in the splenium compared with nonsmokers. FA did not differ between groups in the genu, and neither trace nor white matter volumes differed between groups in any of the regions of interest. When subdivided by Fagerström score (low vs. high), the low Fagerström group exhibited significantly higher FA in the body of the corpus callosum compared with the high Fagerström group and the nonsmokers. These results suggest that, among healthy adults, lower exposure to cigarette smoking is associated with increased microstructural integrity of the white matter compared with either no exposure or higher exposure. Additional studies are needed to further explore differences in white matter integrity between smokers and nonsmokers.

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Introduction

Cigarette smoking has remarkably diverse effects on the central nervous system (CNS). Nicotine is an agonist within the cholinergic neurotransmitter system, with high affinity for the $\alpha 4\beta 2$ nicotinic receptor subtype present throughout the CNS (for review, see Wonnacott, Sidhpura, & Balfour, 2005). Nicotinic receptors are widely distributed within the CNS, and nicotine plays a neuromodulatory role in the cholinergic system, with nicotinic stimulation resulting in multiple interactions with other neurotransmitter systems and alterations in cellular activities (Dani, 2001; Jones, Sudweeks, & Yakel, 1999). These factors reflect the complexity of nicotinic effects in the CNS and also likely explain the beneficial effects of acute nicotine administration on attention, memory, and other cognitive abilities

ISSN 1462-2203 print/ISSN 1469-994X online

DOI: 10.1080/14622200701767829