Cerebral Perfusion Differences in Adult Attention Deficit Hyperactivity Disorder (ADHD)

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Introduction

Attention deficit hyperactivity disorder (ADHD) is a developmental psychiatric disorder clinically defined by impulsiveness, hyperactivity, and inattention. ADHD affects between 3% and 10% of school-age children but often persists into adulthood, and is associated in the long term with reduced educational outcomes and an increased risk of drug abuse and antisocial behaviour.[1-3] At present the neurobiological basis for ADHD has not been fully characterised, but previous neuroimaging studies have reported differences in structure and function in the frontal lobes, basal ganglia, cerebellum, and corpus callosum.[3-6] However, the majority of these studies have focused on children and adolescents with ADHD. The purpose of this study was to investigate differences in regional cerebral perfusion measured with continuous arterial spin labelling (CASL) in adults with ADHD and controls.

Materials and Methods

The subject group consisted of five unmedicated right-handed male patients fulfilling the DSM-IV criteria for ADHD (mean age 32 years, range 21-48) with no history of comorbid psychiatric or neurological illness, or current or past substance abuse. The control group consisted of six right-handed male volunteers (mean age 31 years, range 22-42), with no history of psychiatric or neurological illness. Perfusion images were acquired with a 1.5 T GE Signa Horizon Echospeed scanner (GE Medical Systems, Milwaukee, WI, USA) using a multislice continuous ASL technique.[7,8] The subjects were scanned at the same time of day under identical conditions, and the perfusion images were acquired after approximately 10 minutes of structural MR scanning in order to enable the subjects to acclimatise to the MR environment. The control images from the ASL sequence were registered to a high resolution EPI template image using a fully automated technique which maximises the normalised mutual information from the joint probability distribution between the images.[9] The transformation matrix from this registration was then applied to the perfusion maps, and the difference in perfusion between ADHD subjects and controls was evaluated by fitting an analysis of covariance (ANCOVA) model at each intracerebral voxel, covarying for the potentially confounding effects of age. Regional differences in perfusion were tested at the level of voxel clusters, with the cluster-level significance threshold set to p=0.01.[10]

Results

The results of the group comparison are shown in figure 1. The ADHD subjects demonstrated significantly higher perfusion in the left caudate, left inferior frontal grey matter, centrum semiovale, and left occipital/ posterior temporal lobe. In addition the perfusion was also significantly increased in ADHD subjects bilaterally in the lateral inferior cerebellar hemispheres, although the area of the significant clusters was relatively larger on the right side.

Discussion

Although the neurobiological basis of ADHD has not yet been established, functional neuroimaging studies in children and adolescents suggest widespread differences in frontal, striatal, and cerebellar regions. [3-6] These areas are known to be involved in impulsivity and motor regulation, and the frontal and striatal regions are the major targets for the psychomotor stimulant medications used to control some of the symptoms of ADHD in adults and children. The difference in perfusion observed in the caudate and inferior frontal regions between ADHD subjects and controls therefore provides additional evidence that these areas may be abnormally functioning in ADHD. The corresponding change in perfusion in the right cerebellum further indicates that the entirety of the fronto-striato-cerebellar circuit may be affected. These changes represent the first demonstration of perfusion differences in adults with ADHD and may help to clarify the persistence of ADHD into adulthood.

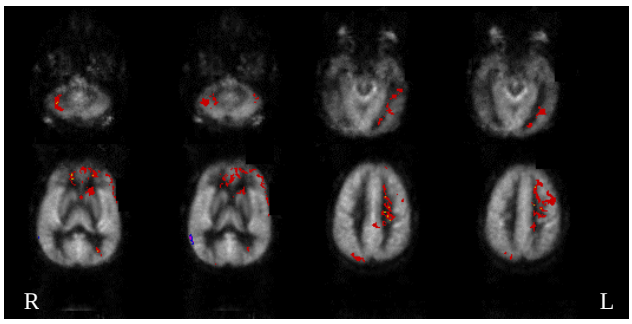

Fig 1

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