Reduction of hippocampal blood flow in collegiate football players

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Target Audience: Clinicians/scientists studying traumatic brain injury and sports, MR neurophysiologists

Introduction: Cumulative head trauma may cause long-term brain injury. Brain injury and subsequent neurodegeneration may be measurable by reduced perfusion. In this study, we sought to determine the baseline differences in perfusion in conjunction with volumetry throughout the brain comparing a cohort of contact sport with non-contact sport student athletes.

Methods: 47 contact (football) and 21 non-contact (volleyball) collegiate male athletes were enrolled in accordance with IRB and HIPAA. A single MRI scan was obtained for each subject. All players were instructed to abstain from caffeine-free for 6 hours prior to scanning. Players were scanned on a GE 3T 750 using the 8HRBrain receive head coil and whole brain T1-weighted IR-FSPGR (3D axial, FOV 24, 256x256, 1mm slice thickness, 182 slices, ARC 1.25, 5 minutes) and noncontrast pseudocontinuous arterial spin labeling (ASL, 3D axial, TR 4800, TE 10.6, BW 62, FOV 220, 128x128, 4 mm thick slices, 63 slices, NEX 3, NEX 1 for the unlabeled proton density image, 4 minutes 50 seconds). A FreeSurfer pipeline utilized the T1-weighted images (http://surfer.nmr.mgh.harvard.edu/) to produce segmentations of the cortex, white matter, and subcortical white matter. These segmentations underwent blinded manual editing. ASL perfusion images were divided by the proton-density images to deliver maps of cerebral blood flow (CBF) in mg/mL/min. The coplanar proton density image was used to align the CBF maps with the T1 volume using FSL's flirt function. FreeSurfer's segmentations of the cerebral cortex, supratentorial white matter, bilateral basal ganglia, thalami, and hippocampi were extracted for volume calculation and used to calculate mean regional CBF across subjects. Volume and CBF was regressed against sport and age for each region. We used a Bonferonni correction for multiple comparisons across the 5 regions tested by selecting a p-value threshold of 0.01.

Results: Mean volumes of the cortex, white matter, basal ganglia, thalami, and hippocampi were statistically equivalent (Table 1). Total hippocampal volume trended towards being smaller in contact sports (p=0.11). Mean CBF of the entire cerebral cortex, white matter, and basal ganglia (BG) were statistically equivalent (Figure 1). The thalami and hippocampi demonstrated significantly reduced CBF in contact compared to non-contact sports (p=0.006 and 0.003, respectively).

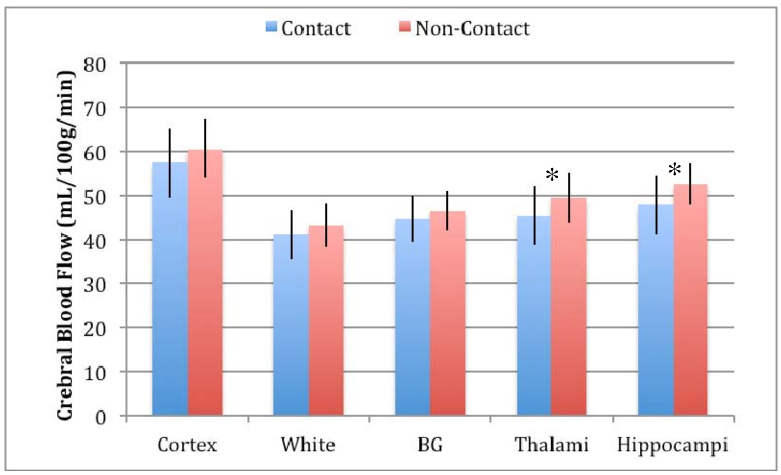

Figure 1: ASL Perfusion

Conclusions: Recent data has suggested that hippocampal volumes are reduced in high contact sports such as football[1]. In this study the total hippocampal volume trended towards being lower in football players, but this difference failed to achieve statistical significance. CBF, however, was clearly reduced in the hippocampi and thalami. If such findings are a consequence of brain trauma, this may represent a more sensitive metric for brain injury than whole-hippocampus volumetry. This presents a new line of data indicative of abnormalities in the hippocampus in contact sports. Future work will compare hippocampal subfield volumetry and subfield perfusion.

	Cortex	White	BG	Thalami	Hippocampi
Contact	584856 ± 46045	504168 ± 50796	25362 ± 1933	17728 ± 1618	9503 ± 1014
Non-Contact	580294 ± 39713	512422 ± 56860	24482 ± 1945	17373 ± 1295	9942 ± 901

Table 1: Volumes of Brain Regions (mm^3)

References:
1. Bellgowan et. al, JAMA 2014.

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