Effects of High-Fat High-Carbohydrate Diet on White Matter Integrity: A Diffusion Tensor Imaging Study in Wistar Rats

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Introduction: Obesity worldwide has reached epidemic proportions, with more than 400 million people affected. Currently, every third person in the world is overweight. Human DTI studies have demonstrated lower fractional anisotrophy (FA) and higher mean diffusivity (MD) in obese humans [1,2]. In animal models, high-fat high-carbohydrate diet (HFCD) is commonly used to induce obesity. We evaluate hypotheses that long-term HFCD use in male Wistar rats leads to Lower FA and higher MD than in control group.

Methods: Twenty five male Wistar rats were put on HFCD (~40% fat, ~40% carbohydrates, ~7% proteins) on their 55th day of life, while 25 control male rats (CON) remained on chow; we obtained DTI data on 21 CON. MR measurements were performed on a 7T wide bore (30 cm) Bruker BioSpec at Mossakowski Medical Research Centre, Warsaw, Poland. Diffusion tensor was acquired with TE/TR=33/3750ms, along 72 directions, with resolution 0.156x0.172x0.7mm, no gap. Data were skull stripped and eddy-current corrected with FSL. Than, images were resized to 0.1x0.1x0.1 mm. FA images were than normalized to a study specific template using DARTEL in SPM8; Study-specific template was created by averaging all FA images. These transformations were applied to FA, MD, as well as perpendicular and parallel diffusivities. Images after normalization and smoothing with a smoothing kernel of 0.3mm at FWHM were compared between groups using two-sample t-tests (FWE<0.05, cluster size >27) with SPM8.

Results: Right cerebral peduncle contains a region of lower MD in in rats fed with HFCD than in CON (p<0.05, FWE), accompanied by increased FA (p<0.001, uncorrected), contrary to our hypotheses. MD is elevated in corpus callosum and fimbria of HFCD-fed rats than in CON, as well as in trigeminal nerve (2b), consistent with our hypothesis. These changes were not accompanied by significant FA changes. No differences in parallel and radial diffusivities were noted.

Conclusions: The results partially support the thesis that high fat high carbohydrate diet leads to worsening of WM integrity. The reason for such behavior is not known.


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