

# CHARACTERIZING MICROSTRUCTURAL ALTERATIONS IN A RAT MODEL OF MILD TRAUMATIC BRAIN INJURY

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## 1. INTRODUCTION

Traumatic brain injury (TBI) is an acquired brain injury that contributes to a substantial number of deaths (mortality rate: 15 per 100 000 in Europe) and a high number of cases of permanent disability (incidence rate: 235 per 100 000 in Europe). Most of the TBI patients have mild TBI (mTBI), a condition that shows no abnormalities on conventional imaging but can result in persisting cognitive defects. Diffusion imaging is an MRI technique sensitive to diffusion of water molecules in the brain and can detect subtle changes in white matter organization. The aim of this study is to investigate whether advanced diffusion MRI scanning can be used to detect microstructural changes in a rat model of mTBI.

## 2. MATERIALS AND METHODS

### 2.1 Animal model

Nine female Wistar rats weighing  $250 \pm 19.6$  g obtained mTBI utilizing the Marmarou weight drop model [1]. In brief, in anesthetized rats a steel helmet was fixed on the skull 1/3 before and 2/3 behind bregma. The rat was positioned under a 450 g brass weight on a foam bed. The weight was dropped from a height of 1m guided through a plexiglass column. The foam bed together with the rat was rapidly removed away from the column to prevent a second injury. Rats were allowed to recover for one week.

### 2.2 Imaging and data analysis

MRI data was acquired on a 7T MRI scanner (PharmaScan, Bruker, Ettlingen) before and 1 week after injury. T2-weighted images were acquired for anatomical reference. Multishell diffusion data was acquired with multiple directions ( $b=800, 1500$  and  $2000$ ; 32, 46 and 64 directions, respectively). Diffusion weighted images were corrected for EPI, motion and eddy current distortions and quantitative maps were

calculated for the diffusion tensor and diffusion kurtosis model in ExploreDTI [2]. Furthermore diffusion kurtosis tensor estimation was done using weighted linear least squares method and maps for white matter metrics were calculated using the model of Fieremans et al. [3]. The maps were co-registered in SPM12 with a template based on the local population and a volume-of-interest analysis was performed in the hippocampus, cingulum and corpus callosum using Amide toolbox [4]. Differences between the two time points were calculated for each map using the Wilcoxon signed-rank test in SPSS.  $P < 0.05$  was considered significant.

## 3. RESULTS AND DISCUSSION

The DTI and DKI metrics were not significantly different between the two time points. The axonal water fraction (AWF) was significantly increased in the cingulum, corpus callosum and hippocampus after mTBI and could be explained by axonal swelling. To verify this hypothesis, histological analysis is currently ongoing. Sections will be stained for synapses, astrocytes, neurons and myelin.

## References

- [1] Marmarou, A. et al. A new model of diffuse brain injury in rats: Part I. *J Neuroscience*, 80, 291-300, 1994.
- [2] Leemans, A. et al. ExploreDTI: a graphical toolbox for processing, analyzing, and visualizing diffusion MR data. In: 17th Annual Meeting of Intl Soc Mag Reson Med, p. 3537, Hawaii, USA, 2009
- [3] Fieremans, E. et al. White matter characterization with diffusional kurtosis imaging, *Neuroimage* 58(1): 177-188, 2011.
- [4] Loening, AM. et al. AMIDE: A Free Software Tool for Multimodality Medical Image Analysis. *Molecular Imaging*, 2(3):131-137, 2003.