MRS of acute mTBI in young athletes

General Leung[1,2], Nathan W Churchill[3], Anthony A Sheen[1], Shaylea Badovinac[4], Marc A Settino[3], Gerald R Moran[5], Todd English[5], Walter Montanera[1,2], Michael G Hutchison[6], and Tom A Schweizer[3,7]

[1]Medical Imaging, St. Michael's Hospital, Toronto, Ontario, Canada, [2]Medical Imaging, University of Toronto, Toronto, Ontario, Canada, [3]Neuroscience Research Program, Keenan Research Centre for Biomedical Science of St. Michael's Hospital, Ontario, Canada, [4]University of Toronto, Ontario, Canada, [5]Siemens Canada Ltd, Ontario, Canada, [6]Concussion Program, Faculty of Kinesiology and Physical Education, University of Toronto, Ontario, Canada, [7]Faculty of Medicine, Neurosurgery, University of Toronto, Ontario, Canada

Introduction: Approximately 20% of mild traumatic brain injury (mTBI) are sports related concussive injuries, of which nearly half receive no medical attention. The motivation of the athlete, as well as the coaching staff and their team mates desire a rapid return to play (RTP). However, during this acute post traumatic period, the brain appears to be more susceptible to injury; even a second mild concussive event during this acute phase can cause significant brain damage[1,2]. Return to play (RTP) guidelines are made further more difficult by studies showing metabolic changes up to 30 days after a concussive event[3]. Proton MRS can be a powerful tool in the evaluation of mTBI with the ability to evaluate various brain metabolites. Previous work has shown that MRS can detect changes in metabolite levels that normalize over time. The aim of this study was to confirm early changes seen in mTBI in a young athlete population and further, evaluate these changes on RTP as well as investigate changes from a healthy baseline, through a concussive event, and finally RTP.

Methods: Athletes were recruited from the University varsity sports program in a study approved by the local REB. To date, 17 healthy controls have been recruited from sports with a high likelihood of head injury (Hockey, Basketball, Rugby and Volleyball). Average age 19.3, 4 males, 14 females. To date, none have had a follow up concussive head injury. 7 other athletes have been recruited (average age 19.8, 3 males, 4 females) who have sustained a sports related concussion. Of these 7, 2 have returned for repeat imaging on return to play. All imaging was done on a 3 T Siemens Skyra with a 20 Ch head/neck coil. 3D T1 MPRAGE sequence was acquired covering the entire brain for good anatomic detail for planning of the spectroscopy voxel. Single voxel, spin echo spectroscopy was acquired for both motor areas in each hemisphere of the brain. The ROI was placed on the pre-central gyrus that contains motor hand function (see Fig 1). Acquisition parameters include TR/TE=2000/30 ms, 1000 Hz bandwidth, 20mm^3 voxel, 50 Hz bandwidth water suppression pulse was used. 100 averages were acquired for a total acquisition time of 3:33 per hemisphere. Raw data were exported to Matlab (2013b), further water peak suppressed and baseline normalized, Lorentzian line shape fit and an area for each peak calculated. Data were grouped into normal and concussion and two tailed t-test was used to evaluate difference between mean metabolite ratios.

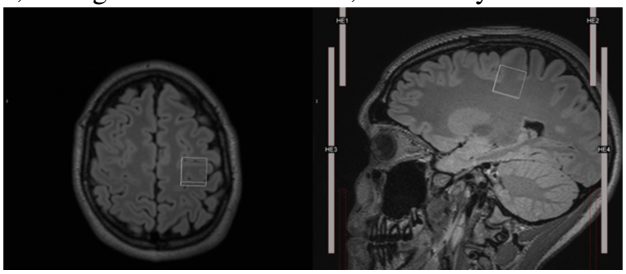

Fig 1: Planning of Spectroscopy Voxel The pre-central gyrus was located from the high resolution 3D T1-MPRAGE. Tight placement in the area of interest without overlapping air was ensured in all orthogonal planes.

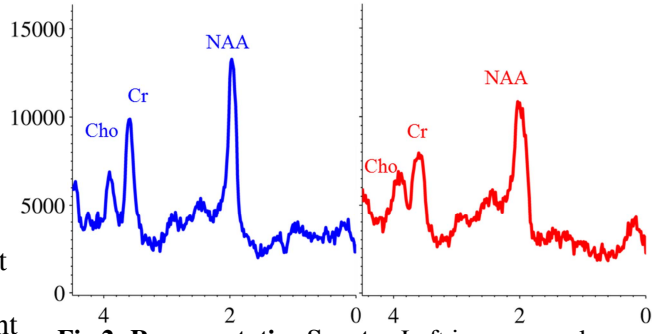

Fig 2: Representative Spectra Left is an example spectra from a healthy control, and the spectra on the right shows a sample spectra from a patient 2 days post concussion. NAA & Cr are both slightly reduced with approximately the same peak area of choline, resulting in a lowered NAA/Cho ratio

Results: For the concussion group, mean time to imaging post event was 3.4 days. NAA appears to be consistent between both groups, however, there does appear to be a decrease in the NAA/Cr ratios (Fig2). Summary data are shown in table 1. Of the two athletes who have been scanned on RTP, both had lowered NAA/Cho ratios immediately post injury, which has returned to control levels by the time they are issued the return to play.

Discussion: NAA/Cho ratio appears to indicate an acute injury during mTBI caused by sports injury. Follow up of athletes scanned at baseline will provide a unique opportunity to evaluate changes in MRS at an acute and chronic stage as well as evaluate return to play.

	Cho/Cr	NAA/Cr	NAA/Cho
Control	0.792+/- 0.03	2.09+/- 0.07	2.68+/- 0.05
Concussion	0.82+/- 0.04	2.04+/-0.06	2.51 +/- 0.06
p-value	0.28	0.28	0.033

Table 1: Summary Results

References 1.Longhi, L. *Neurosurgery* 56, 364–374 (2005).
2. Vagnozzi, R. *Neurosurgery* 62, 1286–1296 (2008). **3.** Giza, C. C. *J Athl Train* 36, 228–235 (2001).