Glycogen and body hydration status are confounders of liver shMOLLI T_1 measurements

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Introduction: The global prevalence of non-alcoholic fatty liver disease is estimated to be 20% and rising[1]. There is therefore an increased need for the development of non-invasive diagnostic, and therapy monitoring methods for this condition as an alternative to liver biopsy, the current reference standard. Recent studies have indicated that shortened Modified Look-Locker Inversion recovery (shMOLLI) T_1 mapping of the liver may be a suitable option[2,3]. However, the relatively high standard deviation in shMOLLI T_1 measurements of healthy individuals' livers is still unexplained (49 ms in liver[2] compared to 25 ms in myocardium[4]). We hypothesise that differences in glycogen and body hydration between participants contribute to this standard deviation. The aim of this study was thus to explore the effects of liver glycogen concentration and hydration changes on liver shMOLLI T_1 values in healthy participants.

Methods: Eight healthy volunteers (3 female, mean age = 31±7 yrs) underwent shMOLLI T_1 mapping, T_2* mapping, MRS PDFF and non-localised natural abundance ^{13}C spectroscopy on a 3 T imager at five defined time points (fig 1): 2 hours after the consumption of a 1300 kcal meal, 12 hours after the first scan after an overnight fasting period, consecutively 2 hours after exercise on a stationary bicycle, then, on a subsequent visit, after 12 hours of fasting including 3 hours of water fasting following another 1300 kcal meal, and finally 1 hour later after drinking 1.5 l of isotonic water. The ratio of the cross-sectional area of the inferior vena cava and the aorta was used as a surrogate marker of hydration and glycogen concentrations were derived from the ^{13}C MRS data using the phantom replacement method[5].

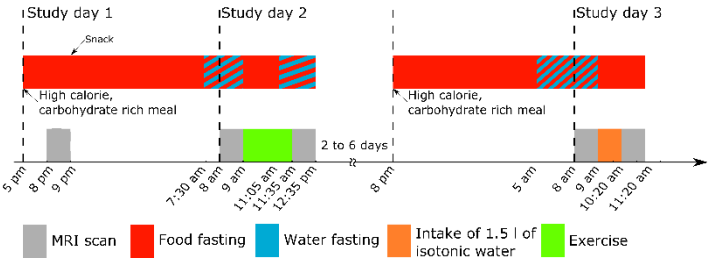

Figure 1 Timing of MRI scans and study procedures

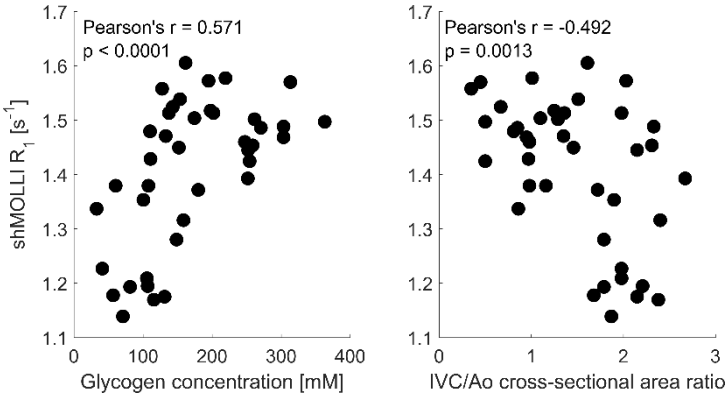

Figure 2 shMOLLI R_1 correlates with both liver glycogen concentration and body hydration status

Results: All participants had T_2* > 17 ms and their PDFF ranged from 0.27% to 3.13%. Measured shMOLLI R_1 values correlated positively with glycogen concentration and negatively with hydration, as shown in fig. 2. There was a mean decrease of 35±24 ms between the fed and the fasted shMOLLI T_1 measurements and a mean increase of 19±28 ms between the water fasted and the over-hydrated shMOLLI T_1 measurements. The results suggest a linear model of the form: $R_1[s^{-1}] = 1.399 - 0.088 \times IVC/Ao\ [s^{-1}] + 0.828 \times Glyco\ [s^{-1}M^{-1}]$.

Discussion and conclusion: Liver shMOLLI T_1 measurements in healthy volunteers are affected by liver glycogen concentration and hydration status. We expect that our findings will have an impact on preparing MRI study participants more carefully by giving specific instructions before scans. The results also inform interpretation of data from subjects who are dieting and patients with impaired liver glyocgen storage.

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References: [1] Younossi et al. Hepatol 2016 [2] Banerjee et al. JHepatol 2014 [3] Pavlides et al. JHepatol 2016 [4] Piechnik et al. JCMR 2013 [5] Lei et al. MRM 2007