Effect of high and low glycemic index recovery diets on skeletal muscle glycogen and lipid storage and utilisation

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Introduction

High levels of carbohydrate intake have been shown to improve glycogen repletion after exercise. Early study reports showed that consuming carbohydrates which are rapidly absorbed into the circulatory system, termed high glycemic index (HGI) carbohydrates, optimised the storage of plasma glucose as skeletal muscle glycogen following glycogen-depleting exercise (1). It has also been reported that the postprandial hyperinsulinaemia accompanying high carbohydrate intake reduces the rate of fat oxidation, increasing reliance upon glycogen oxidation during exercise (1,2). Although high postprandial levels of insulin may increase glycogen storage, the suppression of peripheral lypolysis may increase dependency upon intra muscular stores of glycogen and lipid during exercise.

It is possible that optimising glycogen resynthesis with a high GI recovery diet occurs at the cost of compromised lipid availability. We hypothesised that low glycemic index (LGI) meals consumed after prolonged endurance exercise improve fatty acid availability. The increased ability to oxidise lipid reduces reliance on intramuscular lipid and glycogen stores and liver glycogen in subsequent bouts of exercise.

Methods

Endurance-trained individuals (n = 6) cycled for 90 min at 70% VO_{2peak} and then consumed either high GI (HGI) or low GI (LGI) meals over the following 12 h. After an overnight fast, muscle glycogen and lipid content were assessed before and after a second 90 min cycle. Venous blood samples were collected to observe changes in circulating lipids, glucose, insulin and lactate. Expired air samples were collected to evaluate changes in substrate use during exercise. Each subject performed one HGI and one LGI examination, separated by at least one week.

Immediately after the cessation of exercise, ^{1}H-decoupled ^{13}C spectra and volume-localised ^{1}H spectra were acquired to measure glycogen and lipid content in thigh muscle and liver. Spectra were acquired on a 3T Achieva whole body scanner (Philips, Best, The Netherlands) equipped with a PulseTeq ^{13}C/^{1}H leg coil and a home-built ^{13}C/^{1}H liver coil (^{13}C coil diameters = 6cm and 12cm respectively). Glycogen content was determined from the magnitude of natural abundance C1-glycogen signal at 100.5 ppm, quantitation was performed by comparison of peak magnitudes to spectra from leg- and liver-shaped phantoms containing glycogen solutions of known concentrations. For ^{1}H spectroscopy data the magnitude of resonances originating from intramuscular triglyceride were compared to the magnitude of the water proton resonance from the same voxel. All data were analysed with jMRUI software.

Results and Discussion

Figure 1 shows a typical pre-exercise ^{13}C spectrum acquired from one of the athletes. The C1 resonance of glycogen can be clearly seen at 100.5 ppm (circled). Figure 2 shows the change in muscle glycogen following exercise for LGI and HGI groups. No significant difference was observed between the high and low glycemic index groups, either before or after 90 minutes of exercise. Figure 2 shows the change in intramuscular triglyceride following exercise for the LGI and HGI groups. No significant difference in change following exercise, or between starting and ending IMTG content was observed between the two diet groups. These results demonstrate that GI of carbohydrate consumed in recovery from exercise does not influence the storage or utilisation of skeletal muscle glycogen or lipid during subsequent exercise. The results build on previous findings (2), highlighting the importance of performing MR examinations as soon as possible after the end of exercise to measure muscle metabolites.

Acknowledgements and References

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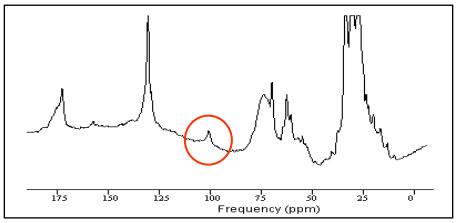

Figure 1 – Typical ^{13}C spectrum acquired from the thigh of a subject prior to exercise. The C1 peak of glycogen can be clearly seen at 100.5 ppm (circled).

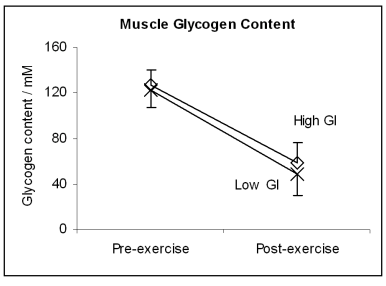

Figure 2 – Change in muscle glycogen content prior to and following exercise for low and high GI diet subject groups

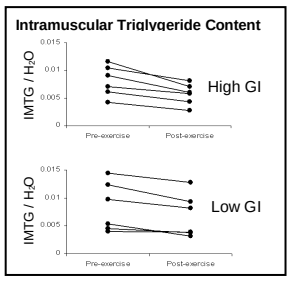

Figure 3 – Change in muscle triglyceride content prior to and following exercise for low and high GI diet subject groups