How does Extracellular Brain Glucose and Lactate change with the Peripheral Blood Glucose?

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Introduction

- Astrocyte-neuron lactate shuffle (ANLS) is a model for carbohydrate metabolism in the brain. The model suggests glucose is first taken in by the astrocytes and is converted into lactate through glycolysis (Pellerin and Magistretti, 2012). Next, the lactate is released into the extracellular environment so that it can be transported into the neurons (Pellerin and Magistretti, 2012). The neurons then use lactate as an energy source and make ATP through the Krebs cycle and Electron Transport Chain (Pellerin and Magistretti, 2012).

- Dringen *et. al.* (1993) has shown that in the presence of glucose, astrocytes accumulate large amounts of glycogen and produce lactate at a significantly high rate.

- Previous studies have confirmed that stress is linked to increased extracellular lactate levels in the brain (Uehara *et. al.* 2007).

- The purpose of the experiment is to determine the effect that increased peripheral blood glucose has on extracellular brain glucose and lactate.

Methods

- The primary motor cortex of four mice were tested

- Extracellular brain glucose and lactate were measured using electrodes, while perfipheral blood glucose and lacate were measured through blood sampling with a glucometer and lactate meter respectively.

- During the experiment, glucose was injected into the mouse through an IP injection (2g of glucose was injected per mice). For two hours, the peripheral glucose and lactate levels and central glucose and lactate levels were measured approximately 5 minutes

- Concentrations of peripheral glucose and lactate and extracellular glucose and lactate were converted into percentage change in concentration from baseline.

[1]The date for Figure **2** was not obtained from the current investigation. It was obtained from a previous study performed in Dr. Messier's Lab.

Results

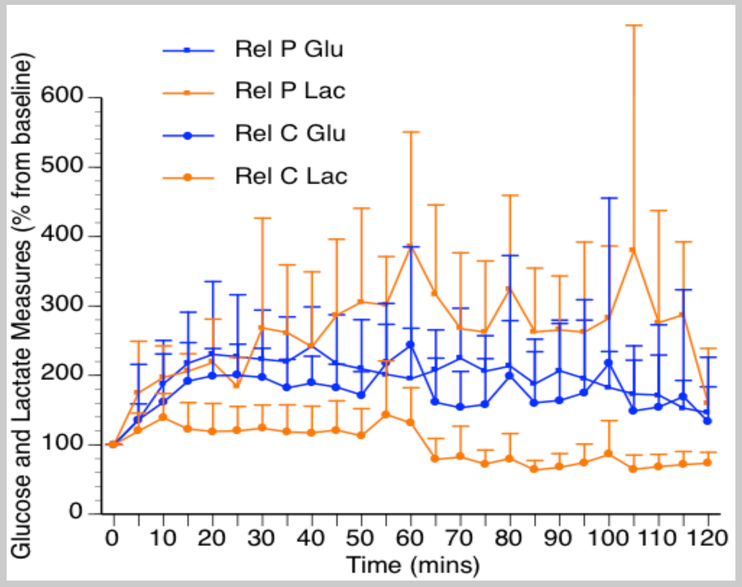

Figure 1: Average Peripheral and Central Measures of Glucose and Lactate over time following IP Injection of Glucose (2g/kg) in the four mice. Graph shows the percent change in concentration from a baseline. The peripheral glucose and lactate levels and central glucose levels initially increase and then gradually decrease back towards the baseline level. The central lactate levels remain relatively constant throughout the entire two hours. Mean + Standard Deviation is present (n=4).

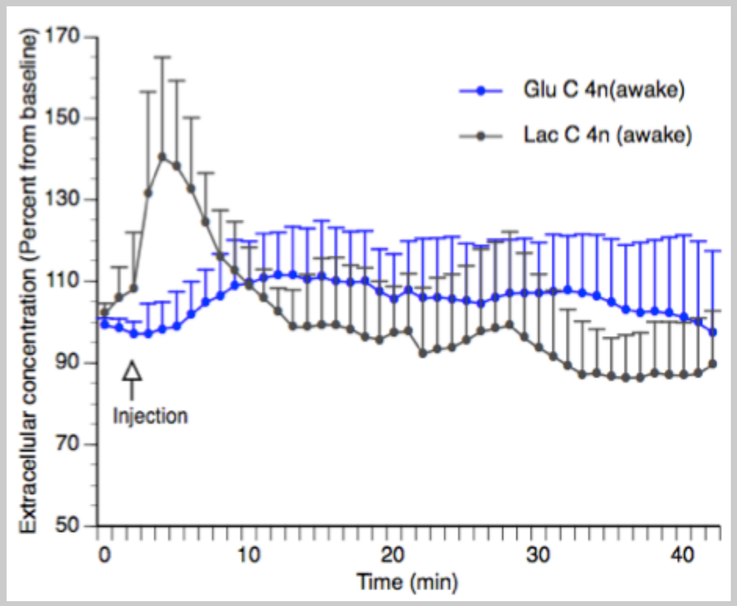

Figure 2: Average Extracellular Glucose and Lactate Concentration over time following IP Injection of Saline (0.9%). Graph shows the percent change in concentration from a baseline. Central glucose levels initially increase, but gradually reverts to the baseline. The central lactate levels initally peak at about 5 minutes and then returns back to the baseline. Mean + Standard Deviation is present (n=4).[1]

Conclusion

- According to **Figure 1**, IP glucose injection leads to increased central glucose levels, but not change in the central lactate levels.

- According to **Figure 2**, IP saline injection leads to an initial peak in central lactate levels and relatively minimal change in the central glucose levels.

- When comparing **Figure 1** and **Figure 2**, a key observation made is that the concentration of extracellular brain lactate is attenuated after the IP glucose injection.

- It must be acknowledged that due to great variation in data presented by the large error bars, it is difficult to make a sound interpretation from the results.

Bibliography

1.Pellerin, L. and Magistretti, P.J. 2012. Sweet sixteen for ANLS. Journal of Cerebral Blood Flow & Metabolism 32: pp. 1152-1166

2.Dringen, R., Gebhardt, R., and Hamprecht, B. 1993. Glycogen in astrocytes: possible function as lactate supply for neighboring cells. Brain Research 623: pp. 208-214

3.Uehara, T., Sumiyoshi T., Hiroko I., and Kurachi M. 2007. Role of glutamate transporters in the modulation of stress-induced lactate metabolism in the rat brain. Psychopharmacology 195: pp. 297-302

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2. I want to thank Alexandria Beland for create the graph that is presented in **Figure 2**

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