Journal of Cerebral Blood Flow and Metabolism 2014 vol.34 N3, pages 397-407

Glycolysis and oxidative phosphorylation in neurons and astrocytes during network activity in hippocampal slices

Ivanov A., Malkov A., Waseem T., Mukhtarov M., Buldakova S., Gubkina O., Zilberter M., Zilberter Y.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Network activation triggers a significant energy metabolism increase in both neurons and astrocytes. Questions of the primary neuronal energy substrate (e.g., glucose vs. lactate) as well as the relative contributions of glycolysis and oxidative phosphorylation and their cellular origin (neurons vs. astrocytes) are still a matter of debates. Using simultaneous measurements of electrophysiological and metabolic parameters during synaptic stimulation in hippocampal slices from mature mice, we show that neurons and astrocytes use both glycolysis and oxidative phosphorylation to meet their energy demands. Supplementation or replacement of glucose in artificial cerebrospinal fluid (ACSF) with pyruvate or lactate strongly modifies parameters related to network activity-Triggered energy metabolism. These effects are not induced by changes in ATP content, pH i, Ca 2+ i or accumulation of reactive oxygen species. Our results suggest that during network activation, a significant fraction of NAD(P)H response (its overshoot phase) corresponds to glycolysis and the changes in cytosolic NAD(P)H and mitochondrial FAD are coupled. Our data do not support the hypothesis of a preferential utilization of astrocyte-released lactate by neurons during network activation in slices - instead, we show that during such activity glucose is an effective energy substrate for both neurons and astrocytes.

http://dx.doi.org/10.1038/jcbfm.2013.222

Keywords

astrocytes, energy metabolism, glycolysis, lactate, network activity, neurons