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Computational modeling indicates anaerobic glycogenolytic ATP synthesis contributes little to quadriceps energy balance during exhaustive bicycling exercise

Jeroen Jeneson[1], Joep Schmitz[1,2], Natal van Riel[2], Willemijn Groenendaal[2], Klaas Nicolay[1] and Peter Hilbers[2]

[1] Biomedical NMR
[2] BioModeling and Bioinformatics Group, Department of Biomedical Engineering, Eindhoven University of Technology, Eindhoven, Netherlands

ABSTRACT

It has been proposed that anaerobic glycogenolysis may contribute as much as 20% to cellular ATP synthesis during contractile work on basis of indirect evidence from ^{31}P NMR spectroscopic measurements of proton balance in human limb muscles (1). Here, this hypothesis was tested more rigorously using a systems biology approach. We constructed a computational model of energy metabolism in muscle composed of slow-twitch oxidative, fast-twitch oxidative and fast-twitch glycolytic fibers incorporating mitochondrial and glycogenolytic ATP synthetic pathways operating in parallel. Next, we measured the *in vivo* dynamics of phosphocreatine (PCr), Pi, hexose monophosphates (HMP) and H^+ concentrations in quadriceps muscle of human subjects performing in-magnet bicycling exercise using gated ^{31}P NMR spectroscopy (2). The measured PCr dynamics were then compared to model simulations for different magnitudes of glycogenolytic ATP synthetic flux. In contrast to previous indirect analyses (1), we found that anaerobic ATP synthesis contributions of only 10% or less sufficed to explain energy balance during exercise; this in spite of massive activation of glycogenolysis as evidenced by large accumulations of HMP of up to 10 mM directly following exercise (2).

REFERENCES

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- Jeneson, Schmitz and Nicolay (this meeting)