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Mitochondrial function, CBF and blood oxygenation monitored *in vivo* in gerbils under oxygen deprivation conditions

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Normal mitochondrial function is a critical factor in maintaining cellular homeostasis in the brain as well as in various organs of the body. Due to the involvement of mitochondrial dysfunction in many pathophysiological conditions, real-time *in vivo* monitoring of the mitochondrial metabolic state is crucially important. This type of monitoring in animal models as well as in patients provides real-time data that can help to interpret experimental results or optimize patient treatment. The monitoring of mitochondrial NADH redox state in the brain provides the most important information on the metabolic state of the mitochondria in terms of energy production and intracellular oxygen levels. Nevertheless, monitoring of NADH alone is not sufficient for the understanding of brain function and more parameters must be measured *in vivo*. The aim of this study was to compare the effects of various situations, leading to oxygen deprivation, on cortical mitochondrial function, CBF and microcirculatory blood oxygenation to changes in systemic hemoglobin oxygenation measured by pulse oximetery. Mitochondrial NADH redox state was evaluated by surface fluorometry, CBF was evaluated by laser Doppler flowmetry and microcirculatoy hemoglobin oxygenation by two wavelength reflectometry. The various parameters were measured using a single optical fiber optic probe located and cemented to brain surface. Systemic blood oxygenation was measured by a special small animal adapted pulse oximeter attached to the leg of the gerbil. The models that were tested included systemic perturbation such as moderate hypoxia and anoxia as well as local ischemia induced by carotid artery occlusion in the gerbil (N=10). The results demonstrated that the mitochondrial NADH was the best indicator of intracellular energy balance. The responses of CBF to the various perturbations were not correlated to intracellular oxygen availability or consumption. Microcirculatory blood oxygenation was significantly correlated to CBF. Changes in systemic hemoglobin were recorded mainly under anoxia and hypoxia. In conclusion, these results demonstrated the potential use of mitochondrial NADH together with other hemodynamic parameters for the evaluation of brain viability under systemic (drug efficacy and safety) as well as focal perturbations.

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Analyte sensing for health and fitness

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Detection and measurement of physiological relevant analytes is an essential step for diagnosis and monitoring of health and fitness conditions. The integration of lithography and microfabrication has allowed the miniaturization of medical devices, biosensors and applications in the fields of biological, environmental science, sports and fitness through clinical medicine. The miniaturization of biosensors has enabled new discoveries, diagnoses and treatments by creating novel devices, systems, and analyses. Biosensors are biophysical devices which can detect the presence of specific analytes (e.g. sugars, proteins, hormones, pollutants, toxins). They are also capable of measuring the quantities of these specific substances in the environment and human body. For example, diabetes is a health condition where biosensors have made a significant contribution. According to the National Report from the Center of Disease Control and Prevention, diabetes affects more than $29 million people in the USA alone. The total medical cost for diabetics is around $245 billion dollars a year. Glucose biosensors are a great tool helping diabetic patients to monitor and manage their disease more efficiently and effectively. New advances in these devices such as integrating redundancy and alternative sensing, algorithms and data analytics has allowed for better and more accurate monitoring and treatment of the disease.

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