Abstract

Magnetic resonance spectroscopy (MRS) is a noninvasive technique that enables to follow metabolic processes in selected tissues in vivo. Recently the attention has been focused on metabolic mapping in target organs of insulin action to describe the pathophysiology of insulin resistance.

The aim of our study was to present the practical application of ^{31}P (phosphorus) MRS and ^{1}H (proton) MRS in metabolic studies of skeletal muscle in insulin resistant subjects and in subjects with impaired fasting glucose. The third study was aimed to evaluate the brain metabolism with ^{1}H MRS in healthy controls and subjects with type 1 diabetes during hyperinsulinemia. ^{1}H and ^{31}P MRS were performed using a MR Scanner Siemens Vision operating at 1,5 Tesla. To assess the parameters of glucose metabolism and insulin action oral glucose tolerance test and hyperinsulinemic euglycemic clamp were performed.

The study 1 was aimed to evaluate the skeletal muscle (m. soleus) energetic metabolism in the offspring of hypertensive parents (OH) with a higher level of insulin resistance. The concentrations of selected high energy phosphates (phosphocreatine, inorganic phosphate, adenosintriphosphate, phosphomonoesters, phosphodiesters) were evaluated with ^{31}P MRS. Their amount in OH was comparable to healthy controls. However we found marginally higher ratio of inorganic phosphate/ATP in OH and several correlations among phosphate metabolites and parameters of insulin resistance or blood pressure, which points at the higher activation of the energy metabolism in OH.

The second study examined the metabolic characteristics of intramyocellular lipids (IMCL) in m. tibialis anterior in subjects with impaired fasting glucose with sedentary lifestyle. We used ^{1}H MRS to evaluate the signal intensities of -CH_2- and -CH_3 groups of IMCL. We demonstrated the negative correlation between the IMCL content and serum cholesterol, insulin sensitivity and plasmatic adiponectine level. The second goal of the study was to assess the effect of the telmisartan treatment (160mg/day, 3 weeks) on the IMCL content. The telmisartan administration did not improve insulin sensitivity but resulted in the lower fasting glucose. Telmisartan did not affect the IMCL content in skeletal muscle. However the IMCL compartment lost its association with insulin sensitivity parameters after the treatment and telmisartan probably influenced its metabolic behavior.

The final study was designed to evaluate the effect of hyperinsulinemia on brain metabolism in subjects with type 1 diabetes (T1DM) and healthy controls. We performed the ^{1}H MRS of the parietal white matter and found significant differences in basal concentrations of selected metabolites (N-acetylaspartate, cholin, inositol and creatine) between T1DM and healthy controls, which supports the presumption of negative impact of T1DM on brain metabolism. After the induction of supraphysiological hyperinsulinemia we registered the alteration in glucose concentration and the increase in glutamine concentration in the whole group. Brain metabolism is presumably influenced by supraphysiological hyperinsulinemia.

The dissertation helped to clarify the mechanisms of insulin resistance in skeletal muscle and brain and demonstrated the possibilities of using MRS in this issue.