Hepatic phosphorus metabolite concentrations of patients with type 2 diabetes assessed by ^{31}P 3D MRSI

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Purpose/Introduction

It has been shown that abnormalities in energy metabolism can underlie non-alcoholic fatty liver in insulin-resistant and/or type 2 diabetic patients (1). Recently, we developed novel technique for absolute quantification of phosphorus metabolites in human liver using 3D phosphorus magnetic resonance spectroscopic imaging (^{31}P MRSI) (2).

The purpose of this study was to apply novel protocol and asses in vivo hepatic phosphorus metabolite concentrations of patients with type 2 diabetes and their age and BMI-matched controls.

Subjects and Methods

Group of type 2 diabetes patients (T2DM, n=10, age = 58 ± 2 years, BMI = 27 ± 1kg/m^2) and age and BMI-matched controls (mCON, n=10, age = 61 ± 4 years, BMI = 25 ± 1 kg/m^2) were scanned in prone position in a 3-T Medspec system S300 DBX (Bruker Biospin, Ettlingen, Germany with the surface coil (10-cm dual tuned ^{1}H /^{31}P) positioned under the lateral aspect of the liver. A small cylindrical reference sample (V=1 ml, d=10mm, height=13mm) filled with triphenyl-phosphate (TPP, stable signal at -12 ppm) was placed at a fixed location in the center of the surface coil. The ^{31}P 3D k-space weighted MRSI localization technique with adiabatic B_1 insensitive half-passage excitation pulse was used. The 20x20x20 cm FOV was encoded using 13x13x13 matrix. FIDs (1024 complex points, SW=10000Hz) were acquired after the phase encoding gradients. TR was 1000ms and the whole protocol including setup took approximately 45 minutes. The quantification of hepatic metabolites was performed using a simulated phantom experiment (cylindrical phantom with KH_2PO_4, c=50mmol/l, V=4 l, d=20cm, h=13cm, T_1=2.88s). Data were processed offline using a MRSI software tool developed in our laboratory (3) and were quantified in jMRUI (4) software with the prior knowledge described by Schmid et al.(5). MRS protocol and absolute quantification of ^{31}P metabolites in the human liver, used in this study, was in details described by Chmelik et al.(2).

Results

Results are presented as weighted mean of quantified voxels (T2DM = 56 ± 8 quantified voxels per patient, mCON = 53 ± 10; weighting factor was S/N ratios of quantified signals).

T2DM had 23% and 20% lower Pi and γ-ATP than mCON, whereas mCON had comparable concentrations than recently published young healthy volunteers (yCON) (2)

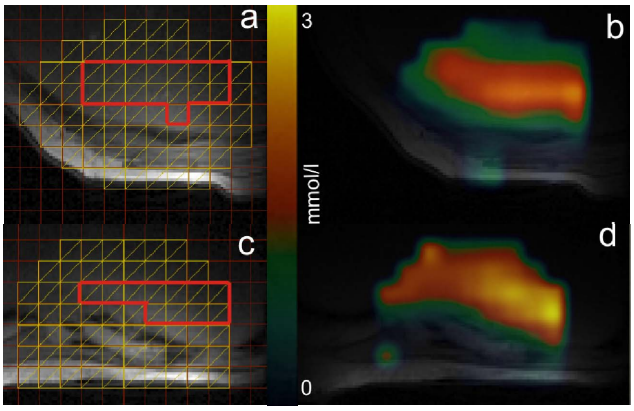

Fig.1 ^{31}P 3D MRSI of T2DM patient's liver (a,b) with γ-ATP mean concentration (c = 1.76 mmol/l) and healthy control (c,d) (c = 2.13 mmol/l).^{1}H images (a,c) show selected voxels highlighted in yellow and voxels used for calculation of mean concentrations outlined by a red line, γ-ATP absolute concentration images (b,d) of voxels in the central slice selected according to (a and c). Note the same scale for both examples.

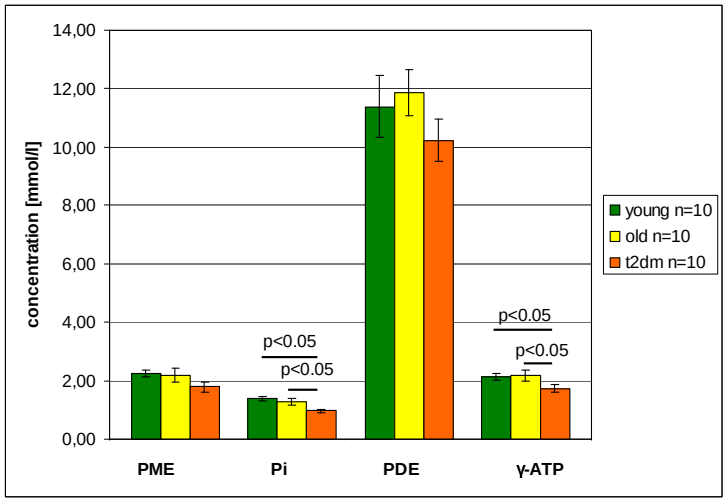

Fig.2 Mean concentrations of ^{31}P hepatic metabolites of young healthy controls* (yCON), T2DM patients amd age and BMI-matched controls (mCON)

Table 1 Absolute values of ^{31}P metabolites in human liver (result in [mmol/l] ± sem)

[mmol/l]	γ-ATP	P_i	PDE	PME
yCon*	**2.14 ± 0.10**	**1.37 ± 0.07**	**11.40 ± 0.96**	**2.24 ± 0.10**
mCon	**2.17 ± 0.18**	**1.26 ± 0.12**	**11.87 ± 0.88**	**2.18 ± 0.26**
T2DM	**1.74 ± 0.11**	**0.96 ± 0.06**	**10.24 ± 0.74**	**1.79 ± 0.17**

*young healthy volunteers (n=10 reproduced from (2))

Discussion/Conclusion

T2DM patients show reduction of heaptic phosphorus (Pi and ATP) concentrations. The reduction of energy metabolites could be explained by abnormalities in hepatic mitochondrial function and insulin resistance of T2DM patients.

References

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