Application of IDEAL-IQ to quantitatively evaluate fat deposition and iron overload in abdominal parenchymal organs in rats with type 2 diabetes mellitus

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BACKGROUD

- The MRI IDEAL-IQ technique was utilized to non-invasively and quantitatively assess fat deposition and iron deposition in the liver, kidney and pancreas of type 2 diabetic rats, as well as to study the relationship between blood glucose, body weight, and fat deposition and iron deposition in type 2 diabetic rats, and to observe the laboratory and pathological alterations between groups.

METHODS

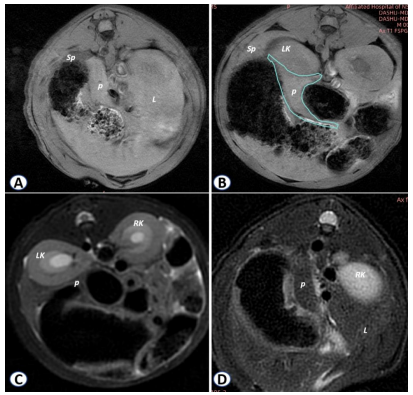
- Ten male SD rats were divided into two groups. The experimental group was subjected to the establishment of a model of type 2 diabetes mellitus, and after the model was formed, an MRI scan was performed to observe the imaging performances between the experimental group and the control group, to quantitatively assess the fat deposition and iron overload in the liver, kidneys, and pancreas, and to assess the changes in liver function, renal function, and lipids by blood sampling from the heart at the end of the scanning process. The liver, kidney and pancreas were taken at execution for routine HE staining to observe cellular changes, oil red O staining to observe fat deposition and Prussian blue iron staining to observe iron deposition. The experimental data were analyzed.

References

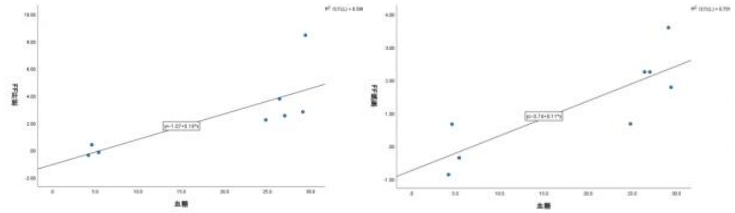
- Xiao B, Xu HB, Jiang ZQ, et al. Acute Pancreatitis in Patients With a Medical History of Type 2 Diabetes Mellitus: Clinical Findings and Magnetic Resonance Imaging Characteristics[J]. Pancreas, 2020, 49(4): 591-597.

RESULTS

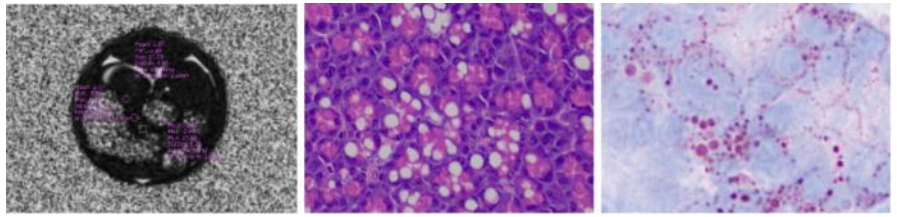
1. Figure 1 MRI images of rats A, B T1WI C, D T2WI Sp: spleen; P: pancreas; LK: left kidney; RK: right kidney; L: liver



2. Figure 2 Correlation analysis of blood glucose with liver FF value and pancreatic FF value.



3. Figure 3 A: IDEAL-IQ fat fraction (FF) map of the pancreatic region of interest in the model group rats; B: HE staining of the pancreas (×400) showing multiple, variably sized, round vacuoles within the islets; C: Oil Red O staining of the pancreas (×400) showing multiple, variably sized, red-stained spherical droplets.



- The blood glucose, body weight, TG and LDL-C of SD rats in the T2DM group were higher than those of the control group, and the FF of the pancreas, liver, right kidney and left kidney as well as the R2* of the pancreas and liver were higher than those of the control group, and the differences were statistically significant ($P < 0.05$). However, the differences in T1 signal intensity and T2 signal intensity of the pancreas, liver, and both kidneys were not statistically significant between the two groups of rats, and the differences in R2*, TC, HDL-C, AST, ALT, UREA, and CREA-M of both kidneys were not statistically significant when compared with those of the control group ($P > 0.05$).Pearson's correlation analysis showed that the differences between blood glucose and FF in the liver (r=0.773), pancreatic FF of the liver (r=0.837), FF of the right kidney (r=0.895), FF of the left kidney (r=0.784), R2* of the liver (r=0.876), and body weight (r=0.980) were positively correlated. Body weight was positively correlated with FF of pancreas (r=0.840), FF of right kidney (r=0.854), FF of left kidney (r=0.796), FF of liver (r=0.834), and FF of pancreas (r=0.778).

CONCLUSION

- This study demonstrated the feasibility of MRI IDEAL-IQ for noninvasive quantitative assessment of liver, pancreas and kidney fat content and iron content in T2DM rats, and concluded that liver and pancreas fat content and iron content in T2DM rats were higher than those in the control group. In the future, this technique may be utilized for early noninvasive quantitative follow-up of newly diagnosed diabetic patients, and for early assessment of alterations in liver, pancreas, and renal composition, in order to prevent organ dysfunction, delay the development of diabetic nephropathy, and provide better prognostic possibilities for diabetic patients.