Quantification of Renal Lipid and Oxygenation in Diabetic Mice by Magnetic Resonance Imaging

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INTRODUCTION

There is growing evidence that abnormal lipid metabolism and renal accumulation of lipids play a role in pathogenesis of diabetic nephropathy. There is also increasing evidence suggesting an association between chronic renal hypoxia and the development and progression of diabetic nephropathy. Noninvasive quantitative measurements would have major advantages in developing novel treatments that target renal lipid accumulation and hypoxia. The purpose of this study was to study the feasibility of in vivo MR measurement of lipid accumulation and oxygenation in kidney in diabetic (db/db) mouse model.

METHODS

Chemical shift imaging (CSI) and blood oxygen level-dependent (BOLD) magnetic resonance imaging were performed to measure kidney lipid contents (LC) and dynamic changes of the renal function on the blood-oxygen saturation before and after exposure to pure nitrogen atmosphere and administration of furosemide in db/db and wild type (WT) control mice using 7 Tesla scanner. Distribution of visceral and subcutaneous adipose tissue and kidney volume were evaluated by T1-weighted imaging.

RESULTS

Kidney LC in db/db mice was significantly higher than that of control group, and lipid accumulation in renal cortex of db/db mice was significantly higher than that of renal medulla. Kidney volume and visceral fat ratio to total white adipose tissue (WAT) in db/db mice were significantly higher than that of WT mice. Linear correlation was observed between MR measurement method and chemical lipid analysis. The lower baseline T2* values in cortex (CO), outer medulla (OM) and inner medulla (IM) of the diabetic mice indicated lower energy reserve than that of control group. The lower T2* values in CO of diabetic kidney after hypoxia and after injection of furosemide that of control group, and significant linear correlation between baseline T2* value and lipid content suggested renal hypoxia potentially due to lipid accumulation in cortex.

CONCLUSION

CSI can detect renal lipid accumulation. BOLD imaging is useful to research renal oxygenation. Lower oxygenation of diabetic kidney indicates renal chronic hypoxia, potentially because of lipid accumulation. MRI has potential to longitudinally study renal diseases resulting from lipotoxicity and hypoxia.

REFERENCES: