

Pancreas fat via Dual-Echo mDIXON Imaging shows that Intracellular Fat does not Accumulate within the Pancreas of Healthy and T2DM Subjects

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Introduction:

¹H-MRS and fat/water MRI studies investigating the effects of pancreatic fat on β -cell function have shown conflicting results [1,2]. These differences could be attributed to the accuracy of the ¹H-MRS or fat/water imaging technique in distinguishing between interlobular pancreatic fat, composed of adipocytes, and actual intracellular fat. Therefore the goal of this study was to establish an mDIXON imaging technique capable of distinguishing between regions of interlobular adipocyte infiltration, in order to accurately measure pancreatic intracellular fat accumulation.

Materials and methods:

All measurements were conducted on a whole body 3.0 T Achieva MRI (Philips Healthcare, The Netherlands), using a 16 channel XL torso phased-array receiver coil.

Participants:

The Study and was comprised of 48 participants: (16 per group) of lean (BMI \leq 25 kg/m²), overweight/obese (BMI $>$ 25 kg/m²), and patients with T2DM. All participants gave written informed consent before inclusion in the study, which was approved by the institutional review ethics board, and all procedures were conducted in accordance with the Declaration of Helsinki.

¹H-MRS:

MRS was conducted with both non-water-suppressed, and VAPOR (WS) STEAM sequences (Single voxel 30x30x20 mm), with respiratory triggering for *in vivo* measurements, as previously described [3].

mDIXON imaging:

Abdominal (F/IP/OP/W) images were acquired in a 19 sec breathhold (BH) via a 3D T1 fast field gradient echo (FFE) pulse sequence (Flip Angle: 5°, TR/TE₁/TE₂: 5.0/1.2/2.5 ms, FOV: 375x295x200 mm³, resolution: 2x2x2 mm). mDIXON fat fraction was also expressed as fat/(water+fat), and obtained pixel by pixel using PRIDE and Low fat PRIDE (LF-PRIDE) software packages (Philips Healthcare, The Netherlands). LF-PRIDE is equipped with a noise reduction algorithm at low fat concentrations. Fat fraction was calculated from the average of four (100 mm³) ROIs placed in different slices within the pancreas avoiding regions of interlobular pancreatic fat.

In vivo results:

Compared to ¹H-MRS of liver fat, LF-PRIDE with noise reduction algorithm resulted in a lower y-intercept (-0.70%) compared to the original PRIDE method (1.77%). Although LF-PRIDE resulted in an overestimation of liver fat (slope = 1.25) compared of PRIDE (0.933), it provided a better correlation to *in vivo* ¹H-MRS results of liver fat ($r^2 = 0.94$ vs. $r^2 = 0.87$) (Figure 1). Pancreas fat from LF-PRIDE (Figure 2) which avoided all regions of interlobular and peripancreatic fat (red circles) revealed clear regions of parenchymal tissue void of any lipid accumulation. Pancreas fat results were below the 2% sensitivity threshold of LF-PRIDE in all participants.

Discussion:

Pancreas fat measurements via Dual-Echo mDixon imaging have been shown previously to be less reliable than those of liver fat, due to irregular organ shape and atrophy [4]. As shown here, a high resolution mDIXON technique was designed with an algorithm for noise reduction at low fat fractions, capable of accurately determining intraparenchymal pancreas fat. Results of LF-PRIDE provide the first non-invasive results that intracellular fat does not accumulate in the pancreas. This is in line with human autopsy findings [5] which report that ectopic pancreas fat consists of adipocyte infiltration, and not intracellular fat.

References

1. Lingvay I et al, J Clin Endocrinol Metab 2009. 2. Heni M et al, Diabetes 2010. 3. Begovatz P et al, ISMRM 2013. 4. Livingstone R et al, MAGMA 2013 (online) 5. Pinnick E Obesity 2008.

