

Pancreatic and Hepatic Fat Measurements using ^1H MRS and mDIXON with Flexible Echo Times.

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Introduction:

In vivo fat assessment by MR techniques of the liver has been widely applied in medicine for non-alcoholic steatosis, type 2 diabetes, and other diseases. To date ^1H MRS has been considered as the gold standard for liver fat measurements due to its sensitivity; however, it is unclear whether ^1H MRS is more accurate than DIXON based methods for the pancreas [1,2]. This is due to differences in anatomy of the pancreas from other organs, such as the liver. The pancreas is a compound gland with loosely packed cell islets which allows for microscopic fatty tissue infiltration and can lead to false ^1H MRS fat measurements.

DIXON methods with 2 or 3 echo times have been often utilized using in- and out-of-phase echo times. Since 2 flexible echo time DIXON has been recently introduced [mDIXON, 3,4], it can provide a higher signal-to-noise by employing very short echo times. Thus the goals of this study were, 1) to evaluate fat content of the liver and pancreas using ^1H MRS and mDIXON, 2) to comparatively analyze the data from the pancreas with data from the liver which is well understood and utilized regarding fat quantification by MR methods.

Materials and methods:

All subjects were locally recruited and consented to a research protocol which was approved by the local review board of human studies (19 healthy volunteers, average age: 57.4 ± 13.1 , range: 30-69, BMI: $26.2 \pm 5.1 \text{ kg/m}^2$).

^1H MRS and mDIXON on pancreas:

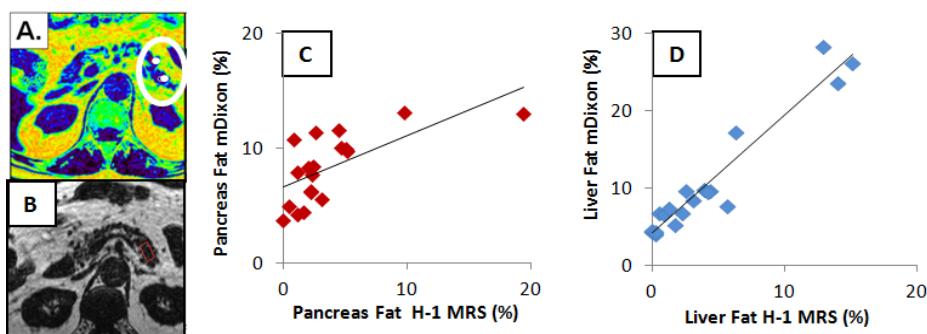
Using a 16 channel XL torso phased-array receive coil at 3.0T (Achieva, Philips Healthcare, Best, Netherlands), MR-Spectroscopy of the pancreatic lipid content was conducted with a single voxel ($20 \times 10 \times 10 \text{ mm}^3$), STEAM sequence with iterative shim (TR/TE= 4000/10ms, 2K data points, BW=2000 Hz, NSA=32) (Typical positioning of the voxel shown in Fig.B). mDIXON abdominal images were acquired in a 17 sec breathhold with a 3D fast gradient echo pulse sequence. (Flip Angle = 10° , TR = 3.2 ms, TE1/ TE2=1.12/2.0 ms, FOV = $375 \times 299 \times 201 \text{ mm}^3$, acq. matrix=236x176x59, recon. matrix=384x384x118).

Data Processing: MRS data was analyzed offline with the NUTS (Acorn NMR Inc, Livermore, CA) software package. The areas of the water and the fat peak (at 1.3 ppm) were fit and fat fraction was expressed as fat/(water+fat). mDIXON fat fraction, also expressed as fat/(water+fat), was obtained pixel by pixel using the PRIDE software package (Fig A) (Philips Healthcare, Best, Netherlands). In order to take advantage of the ability to measure fat inhomogeneity with mDIXON, fat fraction was calculated from the average of four ROIs placed within pancreas in two different slices. Additionally, small ROI's (white dots in the fat MRI, Fig A) with an average volume $34.49 \pm 2.51 \text{ mm}^3$ were chosen to ensure fat fraction measurements within the pancreas, while avoiding contributions of visceral fat.

^1H MRS and mDIXON on liver:

All sequences, parameters, and analyses were identical as in the pancreas, except the sizes of VOI and ROI's. Since the liver is a large and homogeneous organ, the VOI of ^1H MRS was increased to ($30 \times 30 \times 20 \text{ mm}^3$)[5], and fat was calculated from the average of four ROI's placed in the mDIXON fat fraction images.

Results and Discussion:



Values of hepatic fat quantification by mDIXON and ^1H MRS of liver correlated well with each other ($r=0.96$, $p<0.00001$, Fig D), even though the values from mDIXON were consistently higher than the ones from ^1H MRS, and showed a lower limit of ~4% fat. However for the pancreas, even though a correlation ($r=0.66$, $p<0.001$, Fig C) was found, results fluctuated between mDixon and ^1H MRS, which can be potentially attributed to the difference in the amount and distribution of fat between the liver and pancreas.

References

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