MRI Adipose Tissue Volume Measures: Comparison of SPGR and Fast Two Point Dixon Methods at 3T

A. L. Scherzinger[1], Y. Du[2], E. Stamm[1], R. Eckel[3], J. Ma[4]

[1]Radiology, University of Colorado School of Medicine, Denver, CO, United States, [2]Psychiatry, University of Colorado School of Medicine, Denver, CO, United States, [3]Medicine, University of Colorado School of Medicine, Denver, CO, United States, [4]Imaging Physics, University of Texas M. D. Anderson Cancer Center, Houston, Texas, United States

Introduction

MRI is used in many studies to measure subcutaneous (SF) and visceral (VF) fat depots as a correlate to body adiposity [Refs]. In the abdomen, both magnetic and RF field in-homogeneities as well as the presence of structures that mimic the signal intensity of VF, such as vessels and matter within the bowel, complicate segmentation of VF areas. Often the determination of tissue type is dependent on a time consuming clinical review of the image series. At 3T, chemical shift artifacts further complicate segmentation. This study was pursued to determine if a fast two-point Dixon (2PD) technique [1,2] could be used to provide accurate and reproducible measures of subcutaneous and visceral fat in subjects at 3T.

Method

Eight subjects were imaged axially at the level of L4/L5 with both the standard T1-weighted technique (SPGR, out of phase, TR=34ms, flip angle=60^0, slice thickness=5mm) and the 2PD fat/water imaging method (fast spin echo based, TR=3000ms, TE=15.1ms, echo train length = 8, slice thickness=5mm). After data acquisition, the 2PD imaging method generates automatically a water-only and a fat-only image for each slice. These images are installed by the program into the scanner's DICOM image database. Prior to segmentation, the T1-weighted images were processed using a low pass filter and a bilateral adaptive Gaussian filter to reduce effects of field in-homogeneity while preserving edge detail. Histogram based segmentation was then performed, followed by manual intervention when needed. Segmentation of the fat images from the 2PD fat/water imaging technique was done using the same method. Four images, centered at the level of L4/L5, covering a total of 40mm were analyzed. The L4/L5 slice was re-imaged and re-analyzed for a measure of reproducibility.

Results

A T1 weighted (Fig 1a) and fat-only (Fig 1b) image set at one level is presented below. Arrows on the T1 weighted image indicate typical visceral fat patterning adjacent to the posterior abdominal wall. Note also the strong chemical shift displacement here as well in the fat infiltrating the paraspinous muscles. Location of other adipose tissue regions within the visceral cavity is also made difficult by the presence of bowel. The fat-only image clearly indicates location of adipose tissue.

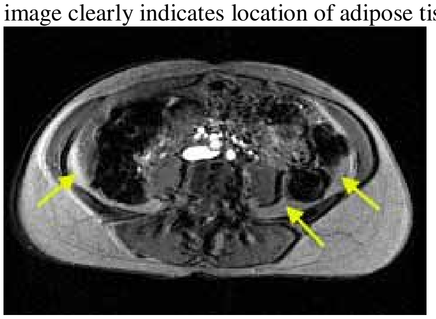

Fig. 1a

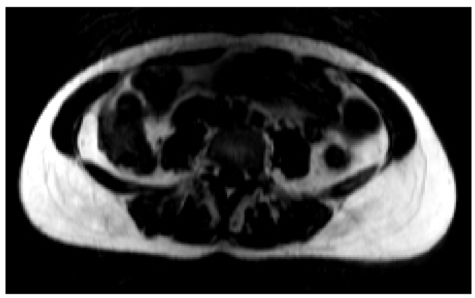

Fig. 1b

Adipose tissue volumes by the 2PD measurement were consistently higher than by the standard T1-weighted method. Strong correlation existed between subcutaneous fat measures by the two techniques (Table 1).

Tissue Type	T1 – Volume	2PD – Volume	Difference (%)	Pearson CC
SF	825 (294)	907 (293)	11 (5)	0.9973
VF	80 (31)	115 (41)	48 (24)	0.8700

Measurement reproducibility was excellent for SF measures by either technique, T1 (CV=1.2%) or 2PD (CV=1.4%). However, a significant increase was seen for the 2PD (CV=6.5%) over the T1 (CV=12.7%) when measuring VF volumes.

Discussion

The 2PD technique used gives a more reproducible measure of SF and VF volumes in the abdomen. The lesser field in-homogeneity of the fat image generated by the 2PD technique makes segmentation more consistent and requires less user interpretation and interaction than analysis of the T1 image set. The lack of correlation of VF volumes between the datasets is consistent with artifactual loss of fat signal at 3T and with the fact that user interpretation is required to distinguish true areas of fat deposition in the T1 weighted image set. This study was supported by NIH grant number 5R01 DK061668-02.

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