Ratios of Visceral and Subcutaneous Fat Mass Are Linearly Correlated with Aging

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Target Audience: Researchers and clinicians interested in metabolism and aging

Introduction:

Increased liver and muscle fat contents were reported in a lean elderly population by ^{1}H MRS studies [1]. Thus, possible role of ectopic fat accumulation with aging is suspected [1,2]. Since it is challenging to pool well-controlled human subjects in standardized physical activity and diet, we examined in 3 different age groups of BL6 mice on a normal chow diet to better understand fat accumulation with aging. Thus the specific goals of this study were, 1) to simultaneously assess whole body subcutaneous, visceral, and liver fat on 3 different age groups of mice, and 2) to investigate an age-related association with body fat content.

Methods:

A total of 14 mice (Five 8 weeks old mice [weight: 28.1±1.5 g]; five 40 weeks old mice [weight: 31.9±2.7 g]; four 80 weeks mice [weight: 36.9±2.7 g]) were studied after IACUC approval.

Experimental: Using an I.D. 7.2 cm volume coil on a 9.4T Bruker scanner, transverse multi-slice spin-echo images were acquired for the whole body of a mouse. Two sets of images with fat-suppression and without fat suppression were acquired. Acquisition parameters were, TR=1500 ms, TE=20 ms, slice thickness/inter-slice distance=1.2/1.5mm, and FOV=4.2x4.2 cm^2 with the matrix size of 342*192. The whole body of a mouse was fully covered with approximately 50 slices, and each slice of fat suppressed and non-fat suppressed MRI are shown in Figure 1.

MRS: In order to assess quantitative hepatic lipids, water STEAM spectra were obtained with water suppression and without water suppression. TR=5 sec for water MRS, TR= 3.5 sec for water suppressed MRS. To minimize errors induced by T2 variation of liver, a short each time (TE=3 msec) was chosen for STEAM MRS (Figure 2).

Data Analysis:

MRI: All data were processed and quantified using SliceOmatic® program (Tomovision, Canada). In brief, each slice was segmented into subcutaneous and visceral fat and other tissues using a region growing scheme based on thresholding, and then all slices of a mouse were summed to yield the total amount of whole body visceral and subcutaneous fat for each mouse. When additional confirmation was needed to identify the borderlines between regions, fat-suppressed MRI's were also utilized as supplemental images for accurate segmentation.

MRS: All MRS spectra were processed using NUTS®(Acorn NMR, CA, USA), liver fat percentage (%) was calculated by the methylene peak at 1.3 ppm in water suppressed MRS, relative to the water peak at 4.7 ppm in water MRS as previously described [3].

Statistics: Statistics were calculated using MedCalc® (MedCalc Software bvba, Belgium).

Results and Discussion:

Liver fat was increased from 1.1% to 1.5% (relative to the water peak) from 8 to 40 weeks old mice, however, at 80 weeks, a small decrease to 0.8% was observed compared to 40 weeks old mice, without statistical significance. As shown in Figure 3, visceral fat increased continuously till 80 weeks. Of interest, it was found that each individual fat mass does not correlated with aging throughout all age groups, but does significantly increase in a shorter span (from 8 to 40 weeks). However, relative ratios of visceral and subcutaneous fat increased throughout all ages with statistical significance ($p<0.05$) as shown in Figure 4. In conclusion, the relative ratios between visceral and subcutaneous fat were linearly correlated with aging for a longer span than individual fat mass.

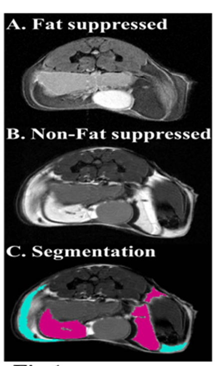

Fig.1

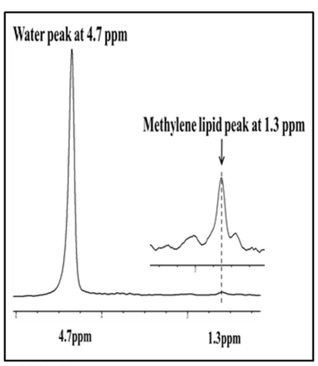

Fig.2

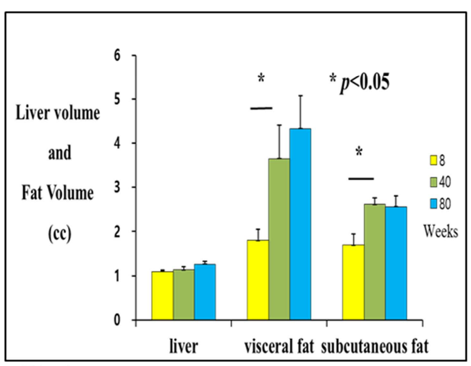

Fig.3

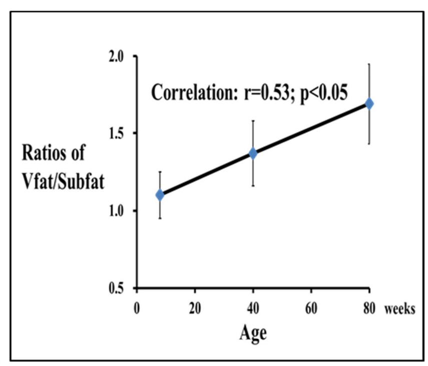

Fig.4

References: 1.Petersen KF, Befroy D, Dufour S, et al. Science, 2003;300:1140–1142. 2. Szendroedi J, Roden M. Curr Opin Lipidol. 2009 Feb;20(1):50-6. 3. Machann J, Thamer C, Stefan N, et al., Radiology 2010; 2, 353-363.