Quantification of Adipose Tissue Depots in the Thigh with Two-Point Dixon Imaging: Effect of Fitness Level on Adiposity in Elderly Women

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Introduction

Obesity is a key factor in the degradation of quality of life and healthiness, especially in the elderly. Body fat is ostensibly the defining characteristic of obesity and MRI has been used to quantify fat depots with T1-weighted imaging [1,2], single voxel spectroscopy [3], and fat selective RF pulse methods [4,5]. The two-point Dixon technique [6] has been recently implemented to study subcutaneous, intermuscular, and intramuscular fat content in the thigh [7]. In this study, we also used a Dixon method to investigate the fat depots in the thighs of elderly women from three different groups: obese, lean but sedentary, and lean and active. By comparing the thigh fat content and distribution in these different groups, we aim to investigate the link between adiposity and fitness.

Materials and Methods

Subjects: A total of forty-one elderly Midwestern American women (age >= 59) comprising three groups: obese (O); lean, but sedentary (LS); and lean and active (LA) were examined in this study. Women with a body mass index (BMI) greater than 28 were assigned to group O (n=24). Women with a BMI between 20 and 24.9 were assigned into groups LS (n=8) and LA (n=9) based on their daily activity level as determined by a pedometer.

In vivo measurements: All data was collected on a Siemens Magnetom Trio 3T whole-body scanner (Siemens AG Medical Solutions, Erlangen, Germany) with the subjects oriented in a feet-first supine position. Scanning was performed using a combination of an eight-channel spine coil and a flexible body matrix surface coil centered over the midpoint of the left thigh. Two-point Dixon imaging was performed in seven adjacent slices centered on the midpoint of the left thigh with the following parameters: TR/TE1/TE2 = 241/2.45/3.99ms, FOV = 25x25cm^2, matrix size = 256x256, and slice thickness = 10cm.

Quantification of Fat Depots: ROIs for subcutaneous fat (SUBQ), intermuscular fat (INTER), and muscle (MUSC) were drawn using thresholds in the center slice of the fat- and water-separated images in Amira (Visage Imaging GmbH, Berlin, Germany) as shown in Figure 1C. Relative areas for these depots were determined against the total area of the thigh minus the bone (TOTAL). Intramuscular fat concentration ([INTRA]) was calculated from the intensity of the fat-separated image in the quadriceps muscle relative to the unseaprated image intensity.

Statistical Analysis: Student's t-test was performed for the three relative areas and intramuscular fat concentration found in Table 1. The tests were performed with unequal variances, one-tailed distributions, and null hypotheses: $\mu_O - \mu_{LS} \leq 0$, $\mu_O - \mu_{LA} \leq 0$, and $\mu_{LS} - \mu_{LA} \leq 0$.

Table 1, summary of results for both absolute and relative fat volumes across all groups

	Obese (O)	Lean, sedentary (LS) / active (LA)	
	$\mu_o \pm \sigma_o$	$\mu_{LS} \pm \sigma_{LS}$	$\mu_{LA} \pm \sigma_{LA}$
SUBQ (cm²)	163 ± 50	115 ± 24	94 ± 32
INTER (cm²)	31 ± 9	22 ± 3	18 ± 5
MUSC (cm²)	86 ± 13	71 ± 7	84 ± 16
TOTAL (cm²)	280 ± 52	208 ± 29	196 ± 30
SUBQ (%)	57 ± 8	55 ± 5	47 ± 10
INTER (%)	11 ± 3	10.7 ± 1.5	9 ± 2
MUSC (%)	31 ± 7	35 ± 4	44 ± 11
[INTRA] (%)	9.7 ± 1.8	9.0 ± 0.9	8.5 ± 1.5

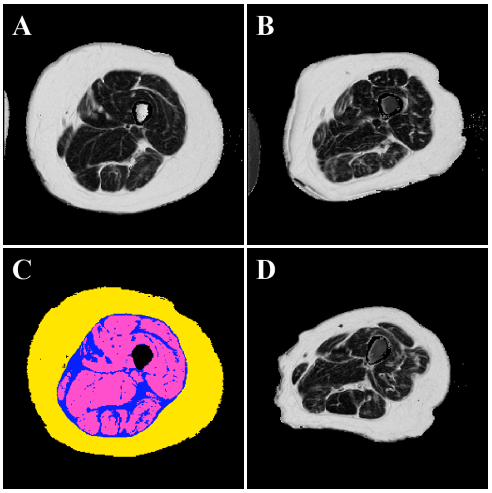

Figure 1. Sample fat separated images for (A) obese, (B) lean and sedentary, and (D) lean and active. Regions of interest are shown in (C) for SUBQ (yellow), INTER (blue), and MUSC (pink).

Results

Fitness Levels: While the thighs of obese subjects were found to be larger than those of lean subjects, no significant differences were found in relative areas of subcutaneous and intermuscular fat depots, between groups O and LS, nor in the intramuscular fat concentration between the groups. This was in contrast to group O having higher relative fat areas than group LA (SUBQ, $p < 0.01$; INTER, $p < 0.05$), and a higher intramuscular fat concentration ([INTRA], $p < 0.05$). Despite having similar total areas, the compositions of thighs in groups LS and LA were significantly different in fat content and distribution. Relative areas for SUBQ ($p < 0.05$) and INTER ($p < 0.1$) were greater in group LS while MUSC was greater in group LA ($p < 0.05$). Group LS also had a greater [INTRA] ($p < 0.1$).

Discussion and Conclusions

Two-point Dixon imaging was used to quantify adipose tissue depots in the thigh in a cross-sectional study of elderly women. Subjects were grouped based on BMI and physical activity, and the results demonstrated that obese women (unfit) had a larger percentage of fatty tissue compared to lean, active women (fit), as is consistent with previous results [8]. However, the lack of differences between lean, sedentary women and obese women indicate that the LS group may also be considered unfit, despite having a normal BMI. These results demonstrate that normal-weight, sedentary individuals may be at risk for the same mobility limitations that plague obese individuals, due to similarities in thigh composition and fat distribution.

References

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