Changes in Muscular Lipid Storage After Diet or Exercise in Elderly Obese Women

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INTRODUCTION: USA population statistics indicate that ~70% of women over 60 years of age are overweight or obese [1]. Obesity in the elderly is linked to disability and disease [2,3], and non-invasive methods to assess the efficacy of various methods for improving their fitness are necessary. Lipids contained within muscle are speculated to reduce muscle quality both from a fuel and muscle strength perspective. In this study, proton magnetic resonance spectroscopy (MRS) [4,5] is used to quantify adiposity through intramuscular triglyceride (IMTG) lipid storage in the skeletal muscle of obese, elderly women. Following on a cross-sectional study of elderly women blocked on adiposity (normal weight/obese) and physical fitness (lean/sedentary) with MRS [6], this is a longitudinal study of the obese women from the cohort randomized to either a diet program or a weight stable exercise program in order to explore the sensitivity of MRS measures to histochemically known perturbations of muscle quality.

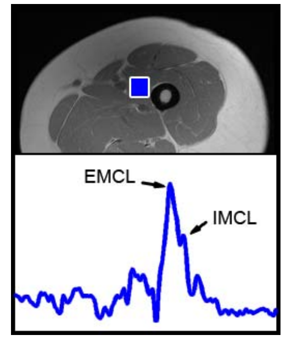

FIG 1: MRS voxel location and example spectrum

METHODS: A total of eighteen obese, elderly women (BMI > 28; age > 59) were recruited for a four-month weight loss or exercise training intervention. Subjects were randomly slotted to participate in either a diet-based (DI) or exercise-based (EX) intervention. The DI group was placed on an energy-restricted diet (initial decrease of 500 kcal/day up to 1400 kcal/day over course of intervention), intended to elicit approximately 10% weight loss (approximately 1% per week). The EX group participated in exercise training without caloric restriction consisting of three supervised sessions a week of combined endurance and strength training for 90 minutes, with intensity increasing from 65-75% $VO_{2,peak}$ to 70-85%. ***Single Voxel MRS:*** Each subject was scanned both pre- and post-intervention on a Siemens 3T Trio whole-body scanner using a combination of spine coil (below) and flexible body matrix coil (above) centered over the thigh. The MRS voxel was placed in the left vastus medialis at the midpoint of the thigh, determined by bony landmarks for ensured repeatability of placement for post-scanning. Acquisition was done using a CHESS sequence: voxel size = 15x15x10 mm^3; TR/TE = 2000/30; N_{acq} = 8. Spectra were acquired with and without water suppression using 13 and 2 averages, respectively. An example of the voxel placement and acquired spectra is shown in Figure 1. ***Quantification:*** Acquired spectra were fitted to find the area of water and lipid peaks using Lorentzian functions with Gaussian priors. Intramyocellular lipid (IMCL) and extramyocellular lipid (EMCL) peaks, 1.4 and 1.6 ppm respectively, were determined from water-suppressed data. Relative concentrations, [IMCL] and [EMCL], were defined as the ratio of IMCL and EMCL to total signal from non-water-suppressed data. Total IMTG concentration, [IMTG], was defined as the sum of [IMCL] and [EMCL]. For comparison with MRS measures, triglyceride (TG) content was quantified through blood draws.

RESULTS: Comparisons were made between pre- and post-intervention for both the DI and EX groups for [IMCL], [EMCL], [IMTG], and TG using student's *t*-test. These results are presented graphically in Figure 2, and tabulated in Table 1. Both DI and EX groups experienced a decrease in [IMTG] and [EMCL] with intervention, though these decreases were significant only for the EX group. These findings were corroborated with the TG measures from blood draws. Neither group showed a significant change in [IMCL].

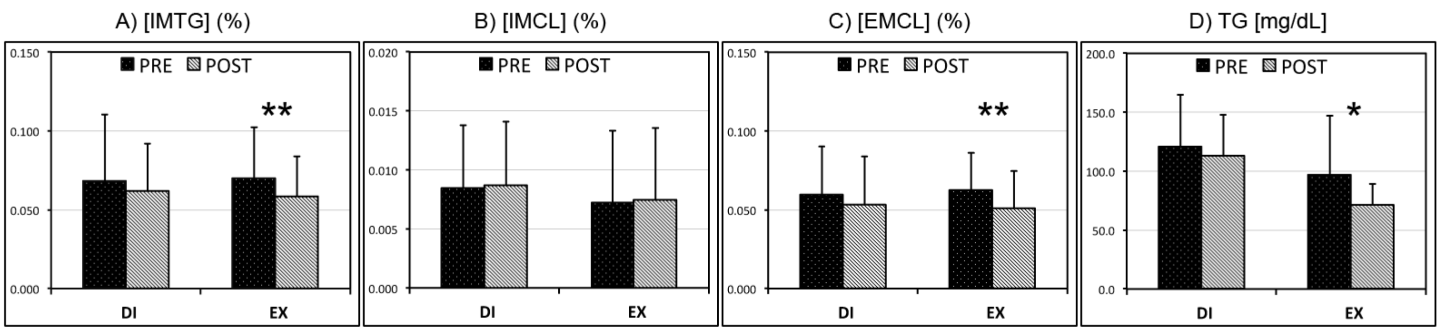

FIG. 2: comparison between PRE and POST [LPD] (A), [IMCL] (B), [EMCL] (C), and TG (D) for DI and EX groups (** $p < 0.05$; * $p < 0.10$)

TABLE 1: calculated lipid concentrations, PRE and POST, for both DI and and EX groups (*p*-value for PRE vs. POST)

	DI Group				EX Group			
	[LPD] (%)	*[IMCL] (%)*	*[EMCL] (%)*	*TG (mg/dL)*	*[LPD] (%)*	*[IMCL] (%)*	*[EMCL] (%)*	*TG (mg/dL)*
PRE	6.82 ± 4.21	0.85 ± 0.41	5.98 ± 4.09	121.0 ± 44.1	6.99 ± 3.22	0.72 ± 0.50	6.27 ± 3.21	96.7 ± 50.1
POST	6.18 ± 3.00	0.87 ± 0.54	5.31 ± 3.07	113.1 ± 34.4	5.82 ± 2.57	0.74 ± 0.61	5.08 ± 2.36	71.5 ± 18.0
***p*-value**	0.3101	0.4629	0.2955	0.3391	**0.0256** (**)	0.4637	**0.0313** (**)	**0.0706** (*)

DISCUSSION: In this study, changes in skeletal muscle lipid storage were compared for two groups of obese women before and after intervention. It was expected that the EX group would see a decrease in lipid storage following intervention. This was confirmed with the MRS data, which showed a significant decrease in EMCL and total IMTG concentrations, as well as TG measures. The lack of decrease in IMCL concentration was expected, as it has been shown to not change with weight loss [7]. In contrast, the DI group did not see any significant differences in lipid storage after intervention. This is consistent with a previous study that did not find significant differences between obese women and lean women who were physically sedentary [6]. The lean/sedentary group can be considered an analog to the DI participants.

CONCLUSIONS: Non-invasive methods, like MRS, can be used to combat obesity in the elderly. In this study, two types of interventions were compared in order to understand the roles of diet and exercise in muscular lipid storage, and ultimately muscle quality. It was found that while diet resulted in weight loss, there was no significant change in lipid storage, while the exercise intervention led to a decrease in lipid concentration and, ostensibly, an increase in muscle quality. These results demonstrate that exercise training in the elderly will increase muscle quality greater than weight loss alone.

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