INTRODUCTION

Previous studies have reported a positive correlation between isometric joint moment and muscle volume [1,2]. Muscle atrophy and strength loss occur with aging, but resistance exercise training in older adults increases muscle mass and strength [3]. In the upper extremity of young adults (24-37 y), individual muscle volumes and isometric joint moments at the shoulder, elbow and wrist have been measured [1,2]. However, there are no comparable data for older adults (age 65 and older). The aim of this study was to characterize muscle volumes and joint moments in older adults and to investigate the effect of a 6 week resistance exercise intervention on muscle volume and isometric joint moment. Therefore, our objective is to measure the individual muscle volume of older adults following a resistance exercise regimen and compare to a control group.

METHODS

Eight ostensibly healthy female subjects were evaluated (66-83 y; wt=49.9-83.9 kg; ht=154.9-167.6 cm). All study participants gave written informed consent. For each participant, muscle volume and isometric joint moment were measured at baseline and follow-up. Four subjects participated in resistance exercise training, while the other four were controls. Subjects in the exercise group met three times per week. Nine exercises for the upper limb were performed, six using machines and three with free weights. Each exercise was performed for 3 sets of 8 repetitions at 60% of the subject’s 1 repetition maximum (1RM), and incrementally increased to 70% and 75% of 1RM at training sessions 6 and 7, respectively.

Subjects were imaged with a 1.5 T MRI scanner (GE Healthcare, Milwaukee, WI) using 3D spoiled gradient (SPGR) scans. The body coil was used to obtain images of the shoulder and upper arm, with a scan time of approximately 10 minutes. A flexed array long bone coil (Invivo, Orlando, FL) was used to obtain images of the upper limb with two successive scans, each lasting approximately 14 minutes.

The MR images were manually segmented (3D Doctor, Able Software Corp., Lexington, MA) to produce a three-dimensional reconstruction of the muscles of interest. A reproducibility study was performed, in which each muscle was segmented twice, showing repeatability within 5% muscle volume. The muscles of interest were selected from each of the main groups of action in the shoulder, elbow, and wrist. These muscles include the biceps brachii (BIC), triceps brachii (TRI), deltoid (DEL), pectoralis major (PEC), coracobrachialis (CBR), latissimus dorsi (LAT), brachioradialis (BRD), extensor carpi radialis (ECR), flexor carpi radialis (FCR), and flexor carpi ulnaris (FCU). Muscle volumes as a percent of total measured volume were calculated.

Maximum isometric joint moment was obtained at the wrist (flexion, extension), elbow (flexion, extension) and shoulder (abduction, adduction) joints using a KIN-COM isokinetic dynamometer (Isokinetic International, Harrison, TN). Analysis of covariance (ANCOVA), with a Bonferroni correction, was used to evaluate the group by time interaction for both muscle volume and isometric joint moment. A p-value of p≤0.005 was considered to be significant.
RESULTS AND DISCUSSION

Muscle volume measurements as a percent of total measured volume for all subjects, pre and post, are shown in Figure 1. On average, the change in volume was (mean±SD) 3.14±5.45% for the exercise group and 0.42±5.02% for controls. Group by time interactions were assessed for each of the muscles. The interaction for the FCR muscle volume was significant (p=0.003).

![Figure 1: Muscle volume as a percent of total muscle volume measured (mean±SD) for exercise and control groups.](image)

Isometric joint moments from pre and post measurements for subjects in the exercise and control groups are shown in Figure 2. The group by time interaction for isometric joint moment was assessed, although none of the joint measures reached significance. We also summed the joint moments to obtain a composite measure of strength [4]. There was a significant group by time interaction (p=0.046), indicating a significant increase in strength in the exercise group. These data suggest that 6 weeks of resistance training are effective for increasing both composite and individual joint strength.

CONCLUSIONS

We conclude that female older adults exhibit a trend of increased strength following 6 weeks of resistance exercise. However, there were no significant increases in total muscle volume. The emerging trend toward increased strength with no muscle volume change may be explained by previous observations, where strength changes were a result of neural components, followed by a slower hypertrophic response [5]. Isometric joint moments tended to increase at all joints following resistance exercise, although our small sample size limited the statistical power to detect differences. These data represent a portion of a larger study that includes male older adults. Preliminary analysis of isometric joint moment measures in this larger group, which includes both male and female subjects, also shows a trend of increased strength following resistance exercise training. Muscle volume measurements and analyses are currently underway for the male subject group. Inclusion of these subjects may provide additional insight into the relationships between muscle volume, resistance exercise, and isometric joint moment in an older adult population.

REFERENCES


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