Effects of Resistance Training and HMB on Muscle Fiber CSA and Body Mass in Aged Rats: A DTI and DEXA Study


Introduction
Aging mammalian skeletal muscles exhibit sarcopenia. Estimates indicate that approximately 45% of older Americans are sarcopenic [1]. Diffusion tensor imaging has shown high accuracy and sensitivity to study muscle architecture and microstructure [2]. In this study, the effects of β-hydroxy-β-methylbutyrate (HMB), which is a dietary supplement that promotes muscle strength and lean body mass (LBM) when associated with resistance training (RT), are investigated in a pre-clinical model of aged rats.

Experimental
Sixteen 19-month-old Sprague-Dawley female rats were divided randomly into three groups: Baseline, HMB (0.46 g/kg b.w./d) and Non-HMB. HMB and Non-HMB groups underwent intense RT (weighted ladder climbing) 3 times/day for 10 weeks. Animals were perfusion fixed using 4% paraformadehyde (PFA) and a trans-cardial procedure, after which the gastrocnemius and soleus muscles were harvested and directly immersed in 4% PFA. The fixed muscle tissues were washed with phosphate buffered saline (PBS) at least one day prior to imaging and immersed in fresh PBS for scanning.

Imaging protocol: DTI images (7 directions) were acquired at 20°C using a widebore 11.75-T vertical magnet with a Bruker Avance console and Micro2.5 gradients. Using a 15-mm birdcage coil, spin-echo (SE) DTI scans were acquired with b values of 0, 500 and 1000 s/mm² at in-plane resolution of 50×50 μm², with a slice thickness of 500 μm. In vivo and prior to sacrifice, pre- and post-RT LBM was assessed by dual energy X-ray absorptiometry (DEXA).

Data Analysis: After acquisition, the images were processed by MedINRIA software to calculate the diffusion tensor, providing the parameters: fraction anisotropy (FA), apparent diffusion coefficient (ADC) and eigenvalues (λ₁, λ₂ and λ₃). A region of interest (ROI) was chosen in the widest region of the soleus muscle for processing. Tukey’s HSD test was used to determine if there were any statistical differences between groups. The statistics was performed using SPSS 17.

Results and Discussion
DTI of the soleus muscle showed that all eigenvalues (λ₁, λ₂ and λ₃) increased (+9%, +17% and +20%, respectively) significantly (p<0.05) in both groups after RT, indicating an increase in cross sectional area (CSA) of the muscle fiber (data is shown in Fig. 1). The increased CSA also was evident in the decreased FA (-30%) and increased ADC (+13%). The findings suggest that the RT muscles are either swollen or contain hypertrophic myofibers due to resistance training. Myogenin mRNA expression increased (+69%, p<0.05) in both RT groups. Overall, RT improved LBM (+21%, p<0.05) in both groups. However, no between-group differences (HMB v. non-HMB) were identified for all variables tested.

Conclusions
Results indicated that HMB failed to facilitate RT-induced changes in LBM, soleus CSA and myogenic response in this study. However, an increase in the CSA of the soleus muscle was identified in addition to associated changes in FA and ADC when compared to the baseline group, which indicates that at least training played a role in muscular maintenance with age. Further studies are underway to determine the effect of age on muscle fibers and the impact of MHB on sedentary conditions.

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References