INTER-INDIVIDUAL AND INTRA-INDIVIDUAL VARIATION OF SPACEFLIGHT-INDUCED MUSCLE ATROPHY: RESULTS FROM THE EDOS-2 STUDY

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During long-term exposure to microgravity multiple musculoskeletal as well as cardiovascular adaptations of the human body including muscular wasting could occur. Due to lower loads of the anti-gravity muscles, especially the lower extremities are affected. To maintain a high level of musculoskeletal fitness, Cosmonauts and Astronauts perform daily exercises. Individual training responses and muscle adaptations are additionally influenced by parameters like body constitution, nutrition, training stimuli and training responses. During our EDOS-2 study we investigated the muscular loss during the long-term space missions despite intensive, high-volume training activities.

Twelve Cosmonauts and Astronauts were examined pre- and post-flight. Two baseline measurements (B-90 and B-45) and three post-flight measurements (R+1, R+14, R+90) at Tibia 38% and Tibia 66% were performed. Data acquisition was performed with a peripheral quantitative computer tomography (pQCT). As a parameter for muscular wasting we used the cross-sectional area (CSA) at the two body sites. Percent change (pc) defined as the difference of the post-flight result and the baseline measurement divided by the baseline result was analyzed. Furthermore, we analyzed the correlation by using the Spearman correlation coefficient between the body sites. These results were compared to muscular adaptations after two month of bed rest without any intervention during our AGBRESA study, where we measured the CSA at Tibia 66 at B-13 and BR60.

Repeated measures ANOVA indicated significant differences between the study days for both measurement sites ($p<0.001$), and contrast testing showed significant losses R+1 as well as R+14. Notably, there was no difference between baseline and R+90. The results of the pc showed an overall decrease of 13.6% (± 5.3) from baseline to R+1 and of 6.4 % (± 4.6) from baseline to R+14 for Tibia 38, respectively. For Tibia 66, the results were -12.7 % (± 5.4) at R+1 and -6.4 % (± 4.3) at R+14. In comparison, the pc of CSA at Tibia 66 during two month of bed rest was about -21.0 % (± 4.5) till BR60. The results for pc of baseline to R+1 showed that the individual pc for Cosmonauts and Astronauts ranged from -22.7 % to -5.4 % at Tibia 38 and from -24.4 % to -5.7 % at Tibia 66, respectively. The range during AGBRESA was from -27.5 % to -14.7 % from baseline to BR60. The correlation coefficients for pc at Tibia 38 and Tibia 66 during EDOS-2 were for R+1 at 0.8, R+14 at 0.6 and R+90 0.3.

Despite daily activities, these results indicate sustained muscle wasting during long-term space missions. These results showed, that the muscular wasting of a long exposure to microgravity (about 6 month) is comparable to adaptations during two month of bed rest without any intervention. The adaptation at Tibia 38 and Tibia 66 showed a high correlation indicating little intra-limb variation.