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Author: Dr. Alina Saveko

State Scientific Center of the Russian Federation Institute of Biomedical Problems of the Russian Academy of Sciences, Russian Federation, asaveko@gmail.com

Mr. Ilya Rukavishnikov

Institute of Biomedical Problems, Russian Academy of Sciences, Russian Federation, sapsan.box@gmail.com

Mr. Nikolay Osetskiy

State Scientific Center of Russian Federation, Institute of Biomedical Problems, Russian Academy of Sciences, Russian Federation, dominicanian13@mail.ru

Mr. Vitaly Brykov

State Scientific Center of Russian Federation, Institute of Biomedical Problems, Russian Academy of Sciences, Russian Federation, hopardd@yandex.ru

Dr. Sergey Ryazanskiy

State Scientific Center of Russian Federation, Institute of Biomedical Problems, Russian Academy of Sciences, Russian Federation, srez@mail.ru

Dr. Elena Tomilovskaya

Institute for Biomedical Problems, Russian Federation, finegold@yandex.ru

Prof. Inesa Kozlovskaya

State Scientific Center of the Russian Federation - Institute of Biomedical Problems of the Russian Academy of Sciences, Russian Federation, ikozlovs@mail.ru

THE BIOMECHANICAL AND ELECTROMYOGRAPHIC CHARACTERISTICS OF WALKING DURING LONG-TERM SPACE FLIGHTS IN ACTIVE AND PASSIVE MODES OF TREADMILL

Abstract

The purpose of the study was to obtain quantitative data of alterations in the biomechanical and electromyographic characteristics of walking during long-term space flights (SF) in active and passive modes of treadmill. Thirteen cosmonauts aged 50.1 +/- 7.4 yr and weight 89.3 +/- 7.1 kg (mean +/- 1 SD) who flew long-duration missions onboard the Russian segment of the International Space Station (mean mission duration of 146.3 +/- 73.1 days) took part in the study. The study was conducted as a part of the onboard experiment "Motocard". During the SF, locomotor tests were performed on a monthly basis onboard the Russian Segment of ISS; moreover, two sessions of the experiment were performed before the SF and one session – on the 8th day after landing. Preflight sessions were conducted 30 and 60 days before the expedition. The locomotor test protocol (walking) was performed twice with an interval of 5–8 min: in the active and passive treadmill modes. In the passive mode, the treadmill was moved by the force of the cosmonaut's legs, and in the active mode - by the electric drive. To estimate the biomechanical parameters of walking, the data of the podogram was used, recorded by 190-197 pressure sensors inbuilt in measuring insoles under the feet of cosmonauts during walking. Also, the electromyogram was recorded from 4 muscles: anterior tibialis, soleus, gastrocnemius and quadriceps femoris. The study allows you to compare the degree of changes of the biomechanical and electromyographic characteristics of walking in different training modes, one of which is accompanied by a more intimate contact of the foot with the surface of the treadmill and, as a result, is associated with an increase of the level of support afferentation.

The total ground reaction forces of walking in the passive mode were higher than in the active one in all the experimental sessions: before SF - by 22.26 +/- 1.36 per cent; during the SF this difference gradually increased by the 2nd month of SF reaching 33.32 +/- 1.21 per cent; further this parameter showed a tendency to decrease, and on the 8th day after SF it consisted 17.85 +/- 0.97 per cent. The support afferentation is a trigger for the activity of the tonic muscle system (Kozlovskaya, I.B. et al., 2007), so the electromyographic profile of walking in different modes of walking is of particular interest. The amplitude of EMG burst of soleus muscle (the most gravity-dependent muscle of the studied) in the passive mode was higher than in the active one in all the experimental sessions: before SF - by 42.06 +/- 2.56 per cent; during the SF this difference reached by the first month of SF 63.02 +/- 4,13 per cent; further this parameter showed a tendency to decrease, and on the 8th day after SF it consisted 13.34 +/- 1.87 per cent. Our results are in accordance to the previously identified biomechanical features of walking during the first months of space flight: the cosmonauts prefer to walk on their toes, what may be a result of optimization of the walking pattern. The study was supported by Roscosmos.