

Abstract

Introduction. Multiple sclerosis (MS) is a chronically progressive neurodegenerative disease. Focal inflammatory changes in the central nervous system cause the appearance of many functional disorders, including paresis, muscle tension disorders, gait disorders, disturbances in body coordination and balance, and sensory and visual disturbances. The symptoms of MS lead to severe disability, gradually limiting activity and participation. Lower extremity muscle strength in MS has been a common purpose of in many studies, while the relationship between lower extremity muscle strength in MS and gait, body balance and fatigue has not been fully elucidated. Also, only a few studies published so far have focused on a detailed assessment of the functional efficiency of patients with MS in subsequent periods of the disease as described in the EDSS scale. The aim of this study was to assess the relationship between the strength of the muscles of the lower extremities and balance, gait and the level of fatigue in people with MS.

Material and method. A cross-sectional study was conducted from January 2019 to June 2020. Inclusion criteria for the study group included: consent to participate in the study, diagnosis of multiple sclerosis according to McDonald's criteria, relapsing-remitting MS, women and men, age from 18 to 60 years, assessment on the Extended Disability Scale (EDSS) ≤ 6 , independent walking or gait with orthopedic support. Exclusion criteria included: cognitive impairment that makes it impossible to understand the questions and instructions during all the assessments provided for in the study, deterioration of health within 30 days before the scheduled test date, severity of symptoms (relapse) of MS within 30 days before the test date, change of pharmacological treatment of MS within 30 days before the test date, treatment with botulinum toxin in the last 6 months before the test date, muscle spasticity of lower extremities greater than 1 plus on the modified Ashworth scale, diseases or injuries other than MS that may disrupt gait or body balance.

A total of 170 people participated in the study, 20 in the pilot study and 150 in the main study. 90 people with MS (study group) and 60 healthy people (control group) were qualified for the main study. People with MS were divided into subgroups according to the severity of symptoms described in the EDSS scale. The study was approved by the Bioethics Committee of the University of Rzeszów and was registered in the Australian New Zealand Clinical Trial Registry. Isokinetic muscle strength was assessed with the use of the Biodex System 4 Pro dynamometric measuring stand, body balance with the use of the TUG test, the Berg scale and the Biodex Balance System SD platform, free and maximum speed of walking in the 10MWT

and 25FWT tests, walking endurance using the 6MWT test and the level of fatigue with the FSS scale.

Results. It has been shown that the functional efficiency of people with MS with moderate and mild disability is statistically significantly different from that of healthy people. Free and maximum gait velocity and walking distance in the 6MWT test in the group of people in the initial stage of MS ($EDSS \leq 3$) were significantly lower compared to the control group ($p = 0.001$). It was found that the strength of the muscles of the lower limbs assessed in isokinetic contraction at the angular velocity of 180 °/s as well as of 300 °/s was statistically significantly lower in the group of people with MS ($EDSS \leq 3$) ($p = 0.001$).

It has been shown that the functional efficiency of people with MS at the subsequent stages of the disease described in the EDSS scale differs significantly. Free and maximum walking speed in the 10MWT and 25FWT test and the walking distance in the 6MWT test in the group of persons with EDSS 3.5 was significantly higher than in persons with EDSS 5.5 ($p = 0.001$). Also, the strength of the muscles of the lower extremities assessed in isokinetic contraction at an angular velocity of 180 °/s and 300 °/s showed that people in the advanced stage of the disease (EDSS 5.5) have significantly lower extensor and flexor muscle strength than people with EDSS 3.5 ($p = 0.001$). The stabilometric assessment of the body balance while standing with eyes open and closed showed that all indicators of posture stability increase with the advancement of the disease. The results of the analysis are statistically significant ($p = 0.001$). It was found that the time to perform the TUG test increased significantly with the increase in the EDSS score. The score in the Berg Balance Scale in the group of people with a score of 5.5 on the EDSS scale was significantly lower than in those with an EDSS of 3.5 ($p = 0.001$).

The analysis of the R rang Spearman's correlation showed that the free and maximum velocity of gait significantly correlated with the strength of the extensor and flexor muscles of the knee joint. It has been shown that with the increase of free and maximum velocity, the value of the average power generated by the extensor muscles of the right knee joint assessed at the angular speed of 180 °/s also increases ($p = 0.001$). It has been shown that the strongest and statistically significant correlation at the angular velocity of 300 °/s is the relationship between the free and the maximum gait velocity assessed in the 10MWT test and the total performed work parameter for the flexor muscles of the left knee joint ($p = 0.001$).

Conclusions. It has been shown that functional efficiency in terms of free velocity and maximum gait endurance, isokinetic strength of the knee extensor and flexors muscles and body balance is significantly lower in patients in the initial stage of MS ($EDSS \leq 3$) in comparison

to healthy ones. The functional efficiency of people with MS significantly decreases with the worsening of the symptoms of the disease described in the EDSS scale, and an important factor contributing to the reduction of the gait function of the body balance and fatigue is the weakening of the strength of the muscles of the lower extremities.

Key words: MS, functional efficiency, gait, balance, strength, fatigue.