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Original research article

The influence of motor ability rehabilitation on temporal-spatial parameters of gait in Huntington's disease patients on the basis of a three-dimensional motion analysis system: An experimental trial

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ABSTRACT

Objective: There is no existing standard, evidence-based, scientific model for motor ability improvement in Huntington's Disease (HD) patients aimed at maintaining independent gait for as long as possible, or performing activities of daily living, the effectiveness of which would be supported by the results of studies using objective research tools. Under these circumstances, the aim of this study was to analyze the influence of motor ability rehabilitation on the spatial-temporal parameters of gait in HD patients.

Design: It was an experimental trial. The studied group consisted of 30 patients (17 women and 13 men) with HD. In hospital conditions, the patients participated in the 3-week motor ability l rehabilitation programme tailored to individual needs. The study group was tested using the Vicon 250 three-dimensional gait analysis system before and after the physical exercise programme.

Results: Walking speed after therapy increased for the left lower limb from 1.06 (SD 0.24) [m/s] to 1.21 (SD 0.23) [m/s], and for the right lower limb from 1.07 (SD 0.25) [m/s] to 1.20 (SD 0.25) [m/s]. The cycle length increased after the applied therapy for the left lower limb from 1.17 (SD 0.20) [m] to 1.23 (SD 0.19) [m].

Conclusion: The three-week motor ability rehabilitation programme positively influences spatial-temporal gait parameters in HD patients.

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1. Introduction

Huntington's disease (HD) is a neurodegenerative, progressive, incurable, hereditary disorder. Impairment of the ability to walk independently may occur in many diseases. Very often, abnormalities in gait pattern are due to diseases of the nervous system. It is believed that gait analysis is the best and only test for assessing pathologies of the nervous system [1]. The abnormalities of gait occurring in HD were qualified by Nutt as middle level gait disturbances, as a result of a pathological condition, in particular within the basal ganglia, caudate nucleus and cerebral cortex [2]. It can therefore be assumed that a person with HD should have his/her own characteristic pattern of gait disturbances, and thanks to this knowledge, it would be possible to programme an efficient motor ability improvement process. In addition, based on the available results of biomechanical studies, we can conclude that kinematic and spatial-temporal parameters of HD patients compared with healthy individuals at the same age will be different [3,4]. The gait of a HD patient is usually on a widened base. In the later stages of HD, patients' gait becomes stiff, cautious and reduces in speed. In addition, with the use of three-dimensional gait analysis, the researchers found the following irregularities during the gait cycle (stride): shortening the length of the gait cycle, extending the duration of the double-support phase, as well as an increase in the diversity of the duration of the gait cycle and step compared to the control group [5–7]. Gait instability, along with imbalances as well as psychiatric and cognition disturbances significantly contribute to falls, which occur in approximately 60% of patients with HD. The risk of falls increases with the progression of this disease [8].

An important aspect of the therapeutic process in HD, in addition to pharmacological treatment, is physiotherapy, which allows to counteract the effects of disease progression and preserve independent functioning of patients for as long as possible. This theory is confirmed by the biological basis of neurorehabilitation and the results of research on the effectiveness of physiotherapy in other diseases such as e.g. Parkinson's disease or strokes [9–11]. In 2009, The European Huntington's Disease Network's Working Group of Physiotherapy published a guide on physiotherapy in HD, including, among others, standardized assessment of the physical condition of the patients and aims of physiotherapy. In the process of gait re-education, a physiotherapist can use the following strategies: stimulation of physical activity by teaching in the form of tasks, learning how to fall and stand up from the ground, training balancing strategies, strengthening the postural muscles [12]. There is no existing standard, evidence-based, scientific model for motor ability improvement aimed at maintaining independent gait for as long as possible, or performing activities of daily living, the effectiveness of which would be supported by the results of studies using objective research tools. Under these circumstances, the aim of this study was to analyze the influence of motor ability rehabilitation on the spatial-temporal parameters of gait in HD patients.

2. Materials and methods

This was an experimental trial. Patients with HD attending the Enroll HD data at the Department of Neurology, University Hospital, Jagiellonian University in Krakow were recruited. After giving their written consent, the eligible patients were clinically examined by an experienced neurologist. Inclusion criteria for the study were: HD diagnosis confirmed by genetic testing, HD motor manifestation at baseline neurological examination, stable and optima pharmacotherapy at least one month before the test and the patient's written consent to participate in the study. While the criteria for exclusion from the study included: abnormal gait preventing the subject to independently walk a distance of 20 m in a straight line, severe cognitive impairment MMSE $<$ 20 score (moderate and severe dementia), behavioural and/or psychotic disturbances preventing effective cooperation, orthopaedic disorders and the consequences of experiencing traumatic lesions to the motor organ permanently disrupting gait pattern and the presence of other chronic or acute conditions having significant impact on health, e.g. cancer, myocardial infarction, chronic pulmonary disease.

Permission to conduct research was issued by the Bioethics Committee of the Approval No.: KBET/59B/2010 and procedures were performed in accordance with the Declaration of Helsinki. Trial ID: ACTRN12617000094370.

Each patient always worked with their assigned, qualified physiotherapist, and the level of difficulty of the motor tasks was adapted to the patient's abilities. In hospital conditions, the patients participated in the 3-week motor ability rehabilitation programme, which consisted of fifteen, 90-minute individual sessions conducted daily, excluding Saturdays and Sundays.

The motor ability rehabilitation programme, whose main objective was gait re-education, was created on the basis of existing scientific reports, as well as the experience and results obtained in the evaluation of gait of patients via the Vicon system. Special attention was paid to the correct position of the pelvis, spinal curvatures, shoulder protraction, and the position of the head, knees and feet during the execution of movement by the patient. Throughout the duration of therapy, emphasis was out on proper breathing patterns, separating consecutive movement exercises by breathing exercises (e.g. blowing up a balloon, blowing soap bubbles, blowing into a tissue located at different distances from the mouth). To carry out the motor tasks, such rehabilitation equipment as handrails, mirrors, gymnastic balls, sensorimotor pillows, poles, coloured tape and weights were used. During the session, closed kinematic chains were used 70% of the time, and through the use of combining the various movement patterns, we obtained global activity of the patient's body. During the motor ability improvement, we focused on increasing the number of repetitions of a motor task, resigning from diversity of exercise. Each session consisted of three parts:

1. Introductory part – warm-up (duration: 10 min)

   The aim was to raise awareness of one's own body, and to improve spatial orientation. This also included learning correct breathing patterns along with lively coordination

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