Abstract

Title: The impact of training with the Luna EMG usage on muscle activity, balance and selected gait parameters of patients after ischemic stroke

Keywords: ischemic stroke, Luna EMG, surface electromyography, muscle activity, lower limb, gait, balance, rehabilitation program, physiotherapy

The aim of the study was to assess the impact of affected lower limb training using the Luna EMG on muscle activity, balance and gait speed of patients after ischemic stroke. Based on the this, the following research questions were formulated:

1. Does and to which extent the rehabilitation program, combined with training using the Luna EMG, affect the activity of the biceps femoris and the rectus femoris of the affected lower limb in patients after ischemic stroke?
2. Does and to which extent the rehabilitation program, combined with training using the Luna EMG, affect the balance in patients after ischemic stroke?
3. Does and to which extent the rehabilitation program, combined with training using the Luna EMG, affect the speed of gait in patients after ischemic stroke?
4. Does and to which extent the adding of training using the Luna EMG to the rehabilitation program affect the strength of the flexor and extensor muscles of the knee joint of the affected lower limb in patients after ischemic stroke?
5. Does and to which extent the rehabilitation program, combined with training using the Luna EMG, affect the range of motion in the knee joint of the affected lower limb in patients after ischemic stroke?

A total of 62 patients were included in the study. In details, 34 women (55%) and 28 men (45%), after ischemic stroke, aged 65-86, staying in the Department of Neurological Rehabilitation of the Non-Public Health Care Center "Rehstab" in Limanowa.

Patients were randomly assigned to one of two groups:

- The experimental group, which underwent 4 weeks of affected lower limb therapy using the Luna EMG, which took place 3 times a week for 20 minutes, and rehabilitation according to a commonly used rehabilitation program after stroke. The total duration of therapy was 2 hours per day, 6 times per week for a period of 4 weeks.
- The control group that underwent rehabilitation according to a commonly used post-stoke rehabilitation program. The total duration of therapy was 2 hours per day, 6 times a week, for a period of 4 weeks.

The study included patients who met the following criteria: the period between 4 and 15 weeks after the primary ischemic stroke, age between 65 and 86 years, limited or impaired function of the lower limbs, functional status allowing for independent or orthopaedic assistance distance of 10 meters and completion of planned tests, muscle strength at the level of min. -3 in a modified MRC scale, mental performance status allowing participation in the study, stable clinical status, written consent of the patient to participate in the study.

Patients were excluded from the studies if at least one of the following criteria was met: hemorrhagic stroke, posterior circulation stroke, lower limb spasticity above 1+ on the modified Ashworth scale, lack of functional capabilities needed to complete selected tests and scales, recent orthopaedic injuries of the lower limb disturbing the balance of the body, previous surgery in the lower limbs, sensory aphasia, other neurological diseases, such as Parkinson's disease, Huntington's disease, lack of consent of the patient to participate in the study, lack of cooperation on the part of the patient.

The rehabilitation process was monitored and supported by a multidisciplinary team that included a specialist in rehabilitation and neurology, a physiotherapist, an occupational therapist, a neurologopedist and a psychologist.

All subjects were assessed for muscle activity, balance, gait, muscle strength and range of motion at the beginning of the study and after 4 weeks of therapy. In order to exclude patients with a significant degree of lower limb spasticity, all patients had their muscle tone assessed at the start of the study according to a modified Ashworth scale. To assess the activity of the rectus femoris and the biceps femoris, surface electromyography tests performed using the Luna EMG were used. The assessment was performed during active extension movement and flexion in the knee joint of the affected limb and during a 5-second isometric contraction. The balance test was assessed by BBS, TIS and PASS tests. The walking speed was measured by the TUG and 10 MWT. The muscle strength of the knee extensors and flexors of the affected limb was also assessed using a modified MRC scale. The active range of motion in the knee joint was measured in addition using a goniometer.

Statistical analysis calculations were performed in IBM SPSS. In order to assess the statistical significance of differences between the two groups in terms of quantitative variables, Mann-Whitney tests were used. In order to assess the statistical significance of differences in the range of quantitative variables between two measurements, the Wilcoxon ranked sign test was used within one group. The relationship between the variables was studied using the Spearman correlation coefficient. The limit of the significance level below which the results were considered statistically significant was $p = 0.05$.

The analysis of the research results led to formulate the following conclusions:

1. The rehabilitation program combined with the training of the affected lower limb by the Luna EMG, has a significant impact on reducing the tension of the rectus femoris during active extension movement in the knee joint and reducing the minimum EMG amplitude of the biceps femoris during active flexion movement in the knee joint of the affected lower limb, in patients after ischemic stroke.
2. The rehabilitation program combined with the training of the affected lower limb by the Luna EMG has a significant positive effect on improving the balance of patients after ischemic stroke.
3. The rehabilitation program combined with the training of the affected lower limb by the Luna EMG has a significant positive effect on improving the gait speed of patients after ischemic stroke.

4. The rehabilitation program combined with the training of the affected lower limb by the Luna EMG has a significant positive effect on improving the strength of the extensor and flexors muscles of the knee joint.
5. The rehabilitation program combined with the training of the affected lower limb by the Luna EMG has a significant positive effect on the improvement of the active flexion range in the knee joint of the affected lower limb in patients after ischemic stroke. No significant effect on the extension range of the knee joint was observed.

The following application conclusions have been defined:

1. The addition of the affected lower limb training using reactive electromyography, with the Luna EMG, to the commonly used rehabilitation program, allows to obtain significant functional improvement in patients after ischemic stroke.
2. The usage of innovative technology in the commonly used rehabilitation program for patients after ischemic stroke allows to achieve effective therapy, with less physical burden on the physiotherapist.