





SCIENCE

Cyclical leg movement training supports stroke rehabilitation

Besides neurological damage, strokes above all lead to decreased mobility in the victim, which in turn can result in secondary illnesses. As well as the physiotherapy and ergotherapy care given to the patients, the effect of training carried out independently on the everyday motor skills of stroke patients must also be examined.

Objectives

The effects on the motor skills of stroke patients on a four-month self-training regime with an exercise therapy device for the lower extremities were examined as part of this study. Above all, it was necessary to establish the influence of the training on the ability to walk and the endurance of the patient.

In addition, the researchers wanted to discover whether regular training with a therapy device of this kind was generally accepted, whether the test subjects used it according to the specifications, and whether they could independently adjust the intensity during the course of the training using the BORG scale to reflect performance progress.

Methodology

A randomised controlled study was carried out. The test subjects were stroke patients living at home with hemiparesis and an existing walking impairment. The subjects had to be physically and mentally capable of participating in the testing and training and following the instructions of the director of studies.

Patients whose general health did not allow them to perform the desired training at the sub-maximal performance level or could not perform regular training due to pain were excluded. Patients who could already train on a conventional bicycle ergometer were also excluded.

Intervention

The patients who fulfilled the above-mentioned inclusion and exclusion criteria were divided into two groups after randomisation. The test subjects in the intervention group (IG) were provided with a movement exerciser, with which, in addition to conventional physiotherapy and ergotherapy, they had to complete a brief 15-minute training session twice per day. Each of these featured passive warm-up and warm-down phases lasting two to three minutes and at least 10 minutes of active training time at a pedalling frequency of 50-70 rotations per minute. During training, the test subjects had to control the activity of the affected leg via a symmetry

display on the device. The brake resistance had to be set up to that it corresponds with level 13 of the BORG scale (“somewhat hard”), which represents moderate endurance training from a scientific training research perspective.

The test subjects in the control group (CG) only received standard physiotherapy and ergotherapy.

Measurements

At the start and end of the intervention period, the walking speed (at a normal and fast pace) was measured with the 10-metre walk (10 MWT) test and the maximum walking distance in a given time was measured in the 2-minute and 6-minute walk tests (2/6 MWT). In addition, motor assessments were carried out: Tinetti Test (TT), Berg Balance Scale (BBS) and Timed “Up & Go”-Test (TUG).

The training data (time, distance, watts, pedalling frequency), was recorded on the devices.

Results

In total, 31 patients (16 IG/15 CG) were included in the study. Gender and lesions were equally divided between the groups. The average age was 65 ± 9 years. Both groups received an average of two sessions of physiotherapy and ergotherapy per week during the intervention period. At the outset, there were clear differences in performance between the test subjects. However, these were evenly distributed, so there were no significant differences between groups.

For the statistical calculations, a significance level of $\alpha = 5\%$ ($p = 0.05$) was established. With the motor tests, a variance analysis was initially performed. If there were significant correlations ($p < 0.05$) between the intervention and control group, a t-test for paired samples was performed.

There were significant interactions between the intervention and control group with the initial values in the 2-MWT (80 ± 38 vs. 70 ± 29 metres; $p = 0.015^*$), the 6-MWT (238 ± 116 vs. 195 ± 88 metres; $p = 0.003^{**}$), the 10-MWT at a normal walking pace (0.65 ± 0.29 vs. 0.58 ± 0.25 metres/sec; $p = 0.024^*$) and in the TUG (22 ± 14 vs. 27 ± 15 seconds; $p = 0.016^*$).

After a before/after analysis of the intervention





group, the paired t-test revealed highly significant improvements in 2-MWT (66 ± 31 vs. 80 ± 38 metres; $p = 0.001^{***}$), the 6-MWT (188 ± 94 vs. 238 ± 116 metres; $p = 0.001^{***}$), the 10-MWT at a normal walking pace (0.53 ± 0.24 vs. 0.65 ± 0.29 metres/sec.; $p = 0.002^{**}$) and in the TUG (29 ± 18 vs. 22 ± 14 seconds; $p = 0.013^*$). This was not the case, however, in the control group.

Using the Pearson correlation coefficient, the researchers could also establish a connection ($r = 0.72$) between the input values from 6-MWT and the average wattage from week 1.

In addition, the evaluation of the training-specific parameters revealed that the training duration and pedalling frequency remained almost unchanged throughout. The participants exercised for an average of 18.20 ± 0.46 minutes. Of this, 16.01 ± 0.29 minutes were active and 2.19 ± 0.17 minutes were passive. The average pedalling frequency was 58 ± 2 rotations per minute. Therefore, it was not possible to establish a connection between the duration and distance ($r = 0.357$) or pedalling frequency and distance ($r = 0.211$) variables.

What did change, however, was the training effort (17 vs. 23 watts; $p = 0.009^{**}$) and the distance (3,388 vs. 4,716 metres; $p = 0.027$). Here, it was possible to prove a conclusive connection ($r = 0.948$) between both variables.

Conclusion

The results of the study show that training with an exercise therapy device improves the sub-maximal performance level of stroke patients. Over the course of the test, subjects were able to increase their training effort by an average of 6 watts and were therefore able to cover much greater distances per training session than at the outset, with an increase of around 1,328 metres. As the scope of the training and the pedalling frequency remained almost unchanged, the increase in effort must have resulted from the change of brake resistance. Reaching a higher gear was therefore evidently a greater incentive for the test subjects. This is supported by the correlation between the parameters ($r = 0.948$) and indicates that the test subjects were able to independently manage the training with the BORG scale. The clear connection



($r = 0.72$) between the input values from 6-MWT and the average wattage from week 1 makes it clear that the strain corresponded to the actual effort of the test subjects and improved this over the course of the test.

Training also had a positive effect on the ability to walk. Endurance and moderate walking speed increased significantly among test subjects in the intervention group. Compared with the values from the initial test, the participants travelled around 50 metres further by the end of the 6-MWT and increased their normal walking speed by an average of 0.12 metres/sec., while the values in the control group remained virtually unchanged.

As the walking distance and walking speed parameters for stroke patients are closely related to independence, it can be assumed that the training also had a positive effect on this. This is partially confirmed by the significant improvements in the TUG, which establishes the degree of independence based on basic motor skills (e.g. standing up from a bed, from a chair or from the toilet). However, the static evaluation of other motor assessments also showed that physical exercise could not improve other skills with everyday relevance or, according to the author, this could not be conclusively proved through the ordinal points scale of the test due to ceiling effects that could not be ruled out.

From the perspective of the authors, a high level compliance is reflected in the positive test results, an average training time above the target training time (the test subjects trained for an average of five minutes longer than predicted) and the high number of training sessions performed (204 ± 56 sessions) per participant.

An additional reliable indication of the motivation of test subjects was increased interest after the study in continuing to train with a movement exerciser. 11 of 16 test subjects consulted their doctor regarding a prescription.

Comments

In any case, physical exercise is a useful addition to physiotherapeutic and ergotherapeutic treatment. This study shows that regular physical exercise improves the sub-maximal performance level of chronic stroke patients and has a positive effect on independence in everyday situations. This confirms

that regular and intensive training is essential to aftercare, in order to ensure that progress is made in rehabilitation and to further improve motor skills and general physical fitness.

It is wrong to expect that no more improvements will be made six months or a year after a stroke. Quite the opposite: through training aimed at the limits of the individual's capabilities, significant improvements can still be made several years later. These no longer result from the restorative approaches but instead from learning theory approaches. Self-training and regular checking of this play a decisive role in this context, as frequent repetition is one of the most important determinants for successful treatment in the context of motor learning. Patients can actively cooperate here by making constructive use of their time when not in treatment. They therefore learn to take responsibility for the rehabilitation process and experience their own self-efficacy. However it is necessary for them to learn to correctly pace themselves and manage the training. However, patients who have received a movement exerciser for training at home are often only briefly trained in operating the device upon delivery and are then left to fend for themselves. Although they make enquiries into how to train correctly, they generally do not receive adequate answers. Against this background, it is a good idea to provide the test subjects with a simple instrument for independent training management in the form of the BORG scale.

The opportunities for effective training management with the movement exerciser should be pursued further in future at all costs. Many patients have a trainer at home but are unlikely to make full use of its potential. Technical software solutions, which provide support for training management, may be helpful in minimising consultancy costs and additionally improve the quality of care.

ORIGINAL WORK

Kamps A, Schule K. Zyklisches Bewegungstraining der unteren Extremitäten in der Schlaganfallrehabilitation [Cyclical physical exercise of the lower extremities in stroke rehabilitation]. *Neuro Rehabil* 2005; 11 (5): 259-269.