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Effectiveness of motor-assisted MOTOmed® movement therapy in the rehabilitation of children diagnosed with infantile cerebral palsy

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Abstract: From 2009 to 2011, 120 patients in the Republican pediatric psycho-neurologic institution received active and passive treatment with the movement therapy device MOTOmed gracile12. In the treatment results, improved gait was measured as one of the biomechanical parameters. Step length was increased from 39.8 cm (15.7 in) to 43.3 cm (17 in). Moreover, active (+ 6.2°) and passive (+ 8.5°) mobility of knee and ankle joint were improved as well. On average, muscle tone could be reduced by one point on the Ashworth scale.

Introduction: Movement is an essential characteristic of all living organisms. It configures the body, activates and strengthens it – from the inside and outside [1]. The term infantile cerebral palsy (ICP) defines movement disorders deriving from infantile brain damage. The disability caused by it is characterized by disorders of the nervous and muscular system in the area of random movement coordination [5].

The Republican psycho-neurologic pediatric institution Prof. Kurbanov is known as an institution specialized on pediatric rehabilitation and offers holistic therapy for children suffering from ICP in many regions of the Republic Uzbekistan. The holistic therapy of children suffering from disorders in the area of random movement coordination is one of the main working aspects in the institution. The most important basic principles of holistic rehabilitation should be mentioned here as well: Each therapy should take place immediately, individually, and multidisciplinary. Moreover, it is very important in the rehabilitation of children with disorders of the central nervous system (CNS) to introduce therapy measures as soon as possible and to integrate the parents into the rehabilitation process [2].

Due to the variety of movement disorders, introducing modern technical aids into the rehabilitation of neurologic patients opens up new perspectives and mostly leads to positive effects. Therefore, active-passive movement therapy with the aid of a movement therapy device represents an effective component of holistic rehabilitation in children suffering from cerebral palsy. The model gracile12 of the company RECK Medizintechnik GmbH (www.motomed.com) belongs to the motor-assisted movement therapy devices mentioned above.

This prospective study aims at verifying the non-objection of motor-assisted movement therapy with the MOTOmed gracile12 movement therapy device in the therapy of children suffering from ICP as well as examining the effectiveness regarding the improvement of gait ability. The present study was carried out with scientific support of a graduate of the German sports university Cologne (Germany).

Study design: From 2009 until 2011, 120 patients with spastic types of cerebral palsy participated in the clinical study on the effectiveness of motor-assisted movement therapy in neurologic rehabilitation. 66 boys (55 %) and 54 girls (45 %) ages between 5 and 14 years (Ø age: 6.7 years) took part in the study.

75 of the test persons (62.5 %) suffered from spastic diplegia, 45 patients (37.5 %) from hemiplegia. Therapy success on motor level was measured in common test procedures (stabilography, dynamometry, and goniometry), pre- and post-test results of each procedure were compared. The Ashworthscale was used in order to evaluate muscle tone or respectively the resistance against passive movement.

In addition to conventional therapy measures, the test persons received cyclic movement training by means of the MOTOmed gracile12 movement therapy device for upper and lower extremities. Moderate intensity (slightly exhausting) was chosen. Medical staff could adapt the preset training parameters (speed, duration, resistance level, movement direction) to the daily condition of each child at any time. During the complete training, safety was ensured by the protective program of the device (MOTOmed Movement-Protector with SpasmControl) which was developed especially for children with spastic movement disorders. This protective program works in the background automatically and is active during training of the upper as well as the lower extremities.

By regular use of motor-assisted movement therapy with the aid of a MOTOmed gracile12 movement therapy device, the following therapy goals were pursued:

1) improvement or maintenance of gait
2) reduce spasticity, ease the musculature
3) remove or alleviate outcomes of lack of movement
4) improvement of the movement coordination
5) improvement of proprioception
6) improvement of the general capability

Exclusion criteria for this study were:
1) evident cognitive restrictions of the test person
2) negative attitude of the test person towards such therapy

MOTOmed training took place in sitting position and under guidance of an experienced movement therapist *(image 1)*. During their inpatient stay of 15 to 20 days the children received an additional daily training from 10 to 25 minutes (depending on age, physical endurance, and the present limitations) on the movement therapy device.

Image 1 Child is training with the MOTOmed gracile12

Each therapy unit consisted of three phases:
1) warm-up: passive training in accordance to the preset parameters (speed, movement direction, duration of training)
2) main part: active or assistive (servo) training with individual intensity
3) finish: active training with lower intensity or passive training

During and after the training, the user received clearly legible feedback on the large screen: training duration, covered distance, performance, muscle tension (spasticity), energy consumption, etc. were displayed on the screen. The achieved results could also be saved permanently and analyzed on a chip card which can be ordered additionally.

Results: Observing patients of different age groups who received an additional training with the MOTOmed gracile12 movement therapy device in the course of holistic therapy lets us come to the conclusion that MOTOmed movement training as therapeutic sports application represents an additional therapy method which in many aspects is effective and efficient for children suffering from cerebral palsy due to its functional and psycho-social effects.

By means of the performance tests, clear improvements in mobility and reduced stiffness of the joints were found in most of the patients. When the study began, the average active training phase of especially "weak" children was less than 15 % whereas the test persons could cycle actively for approx. 50 % of the preset training time in the last training week. In the more "able-bodied" children, an evident increase in covered distance on the MOTOmed gracile12 was documented which on one hand is based on an increased active training duration and on the other hand on the increased performance or respectively an increased exercise tolerance.

After the seventh or eighth day of holistic rehabilitation, an evidently decreased muscle tone, increased muscular strength, and improved general mobility could already be observed in most children who had trained using the MOTOmed gracile12. All children exercised with the MOTOmed by choice and enjoyed it so that their motivation to continue the MOTOmed therapy increased continuously.

The authors of a similar study by Polonskaya et al. in 2010 (Russia) used a MOTOmed gracile12 movement therapy device in combination with functional electric stimulation (FES) and not only observed an improvement in movement kinematics (increased mobility in knee and ankle joint), but also positive dynamic concerning the reduction of muscle tone and the increase of random muscle activity in the extensors [4].

The results of biomechanical tests carried out after the 15th or 20th day of treatment presented the following changes *(table 1):*
1) extension of step length from Ø 39.8 cm (15.7 in) to Ø 43.3 cm (17 in) (+ 8.8 %) which indicates less movement restriction when walking
2) on average, the range of motion of the ankle joint supination was improved by 2.2° and therefore almost complied with the physiologic range of motion

3) the active (Ø + 6.2°) and passive (Ø + 8.5°) range of motion of knee and ankle joint were enlarged *(image 2)*
4) muscle strength was increased by Ø 17.4 %

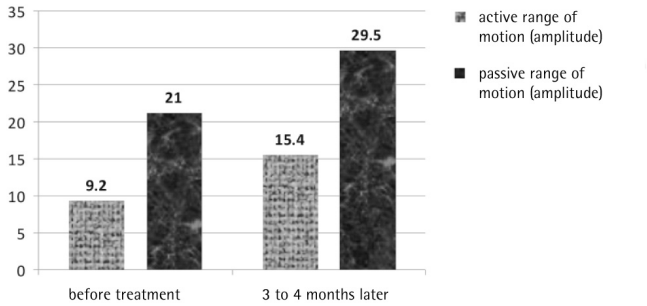

Image 2 Diagram of active and passive range of motion in knee and ankle joint, measured in degrees (°).

Moreover an evidently decreased spastic muscle tone could be observed in the extremitites (Ø ~ -1 level on the Ashworthscale).

Shen et al. achieved similar results in 2009 [7] in their study about children suffering from cerebral palsy who received a daily MOTOmed training for 20 minutes in the context of their holistic therapy (Bobath, Voita, etc.). In comparison to the control group (n = 24), significantly decreased muscle tone ($p < 0.05$) and improved muscle strength in the upper and lower extremities ($p < 0.05$) could be found in the intervention group (n = 24).

The results of interviews with the parents of the children who participated in the MOTOmed study confirmed that approx. 75 % of the children actively tried to randomly move their extremities after the intervention had taken place. More or less complicated motion sequences like crawling or walking could be carried out more easily in those children who received more than 10 – 15 therapy units. Most of the children were able to maintain their achieved biomechanical improvements even after the study period was over if individual holistic therapy measures continued according to the basic principles of rehabilitation.

Summary: Without meaning to belittle the advantages of conventional therapies, the analysis of the results leads to the following conclusions concerning MOTOmed movement therapy:

1) supports the decrease of spastic muscle tone, which leads to an increased range of motion in the corresponding joints
2) supports children in learning complex motion sequences
3) improves balance and gait symmetry
4) increases self-dependence in everyday life
5) preserves resources
6) increases the child's motivation to continue with therapy independently
7) shortens duration of therapy

Effects of regular motor-assisted movement therapy

Functional factors	Pre-test	Post-test	Difference
Step length	39.8 ± 1.62	43.3 ± 1.47	+ 8.8 %
Foot mobility	-1.40 ± 0.94	0.82 ± 0.50*	+ 2.2°
Muscle strength	2.3 ± 0.09	2.7 ± 0.11*	+ 17.4 %
Muscle tone	3.0 ± 0.12	2.1 ± 0.07**	~ -1 level *(Ashworth)*

Table 1 Results marked by asterisk indicate significant differences in the pre-post-comparison: * $p < 0.05$; ** $p < 0.001$.

Particular advantages of motor-assisted movement therapy with the aid of the MOTOmed gracile12 compared to conservative treatment methods in children suffering from ICP:

1) non-invasive therapy method
2) safety and easy operation
3) simultaneous monitoring of several children
4) increases motivation to continue therapy
5) moderate gear control for children with different stages of the illness

The data analysis contributes to the conclusion that motor-assisted MOTOmed movement therapy should be an inherent part in holistic rehabilitation of children suffering from cerebral palsy. Regular use of the MOTOmed gracile12 movement therapy device can contribute to an improvement in mobility and range of motion and therefore offers new perspectives for social adaption of the children into modern society.

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