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Medical Group

Journal of Novel Physiotherapy and Physical Rehabilitation

ISSN: 2455-5487 DOI CC By

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Dates: Received: 16 August, 2017; **Accepted:** 29 August, 2017; **Published:** 31 August, 2017

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Perspective Article

Therapy accompanying use of VR-glasses in hemiparetic children and adolescents

Introduction

Hemiparesis as a result of an ischemic stroke in children and adolescents under 16 years of age is reported in the literature with an incidence of approximately 3-5 and 1,6: 100.000, respectively [1,2]. If the haemorrhagic stroke and sinus thrombosis were included, the number would double. Strokes in newborns have an incidence of about 1: 2.500-4.000 newborns. Based on these causes, many children develop a (mostly spastic) partial paralysis. Physical and occupational therapy are common in the rehabilitation of hemiparesis, recognized in Germany, supplemented by a variety of (partly technical) aids. Untreated children are particularly affected by a developmental disorder, some of them never learn to walk by their own. For many years, the viewpoint of physical therapists focused very strongly on the motor component of the development. This subsequent work goes beyond this and the gain for the child is the increased participation.

Background

Hemiparetic children and adolescents usually impose their affected limbs much less than their motor functions would allow. A part of the motor deficit of the affected person is not only based on the lesion itself and is the reason for the reduced spontaneous use of the hand in everyday life. It appears as if the children and adolescents ignored their affected limb. This is clearly evident in the arm of the person concerned. Taub coined the expression "learned non-use" for this phenomenon because it is a learned behavior and is due to a conditioned behavioral suppression [3]. Through the learned non-use, the return of the movement is considerably suppressed.

In contrast to older children with acquired brain damage, children with pre-, peri- or early postnatal insults of the central nervous system do not have the experience of normal motor functions of the affected limb. For this reason, it is not the previously mentioned learned non-use in these children, but a different phenomenon, which is very similar [4]. Chose the term developmental disregard to describe this phenomenon. This is not the unlearning of the use of the affected limb, but the child does not pay attention to the limb during sensorimotor development. As a result, the sensorimotor development, in addition to the factors caused by the hemiparesis, is severely impaired.

The theoretical basis for the study of the therapeutic use of VR in children and adolescents with hemiparesis is based on the success of mirror therapy [5]. This therapy uses an illusion created by a mirror. The mirror is placed on a table in the center of the child`s body, so that the mirror image of the unaffected arm appears in the mirror as if it were the affected extremity. The view in the mirror produces the subjective impression of the functional, normal movement of the motorized hand [6]. The basic idea of the mirror therapy is the realization that movement observation recruits the same neural structures as the execution of the movement itself [7]. This additional activation of neuronal structures of the affected hemisphere results in cortical reorganization and improved function [8]. By the mirroring of the non-affected extremity, important motor areas are activated in the affected hemisphere, which could otherwise only be activated by voluntary movements of the affected limb itself [9].

An explanation attempt by Small et al. [10]. describes the activation of mirror neurons can be used to induce functional changes in patients after ischemic stroke. The system of mirror neurons is responsible for learning new abilities by visual observation of activity [11]. The mirror neurons can specifically activate motor brain regions by motion observation [6]. An important triggering condition is the observation of an object-related action. In addition, a reaction occurs only when considering complex actions and not in single movements.

The situation of reduced use of the affected limb after stroke is associated with a marked reduction in the cortical representation of the affected limb [12]. This reduced representation of the affected limb in the motor cortex can also be increased in the chronic stage by rehabilitation measures [13]. In one study, changes in the topographic pattern in adult

Citation: Jung M, Höning J (2017) Therapy accompanying use of VR-glasses in hemiparetic children and adolescents. J Nov Physiother Phys Rehabil 4(4): 087-089. DOI: http://doi.org/10.17352/2455-5487.000054

stroke patients were demonstrated by mirror therapy [14]. A part of the clinically relevant motor function improvement of the upper limb could be attributed to this change [8], demonstrated in a RCT (n = 40), using fMRI, that mirror therapy had a positive effect on the disrupted interhemispheric inhibition. In the intervention group, mirror therapy led to a shift in the activity balance of the primary motor cortex toward the affected hemisphere. This is particularly important, since a successful rehabilitation after stroke (function improvement) is attributed among other things to a balanced activation of the hemispheres [15].

Objective

In this study the researchers are going to look for a therapy accompanying use and positive effect of VR-glasses in hemiparetic children and adolescents.

The following questions are to be clarified with this study

- Is there an improvement in manual dexterity after the 12 weeks "treatment"?
- Is there an improvement in the walking speed after the 12 weeks "treatment"?
- Is there an improvement in cardiopulmonary endurance after the 12 weeks "treatment"?

Method

Similar to mirror therapy, a situation, a picture or a movement sequence is presented to the brain in the therapy-accompanying treatment with the virtual reality spectacles (Samsung VR glasses) in such a way that the patient believes that his affected limb would be actively involved, thus causing the corresponding brain area of the affected side [16,8]. Studies in adults have shown that it is possible to learn motor movements in the virtual reality and then to implement them in the real world [17,18]. Since there is little evidence for this case in children with hemiparesis, this pilot study is being carried out. The design of the pilot study corresponds to a 12-week prospective cohort study with single blinded evaluation. The children and adolescents are examined with the tests shown in table 1 at four measurement times.

The study was approved by the ethics committee of Fresenius University. Patients were recruited with the help of the Department of Neuropaediatrics at the Goethe-University Frankfurt. The patients had to meet the following inclusion and exclusion criteria (Table 2).

The intervention with VR-glasses is carried out for children and adolescents with a hemiparesis for 12 weeks, every day for 15 minutes. The parents of the study participants receive a Samsung smartphone and the associated VR-glasses as well as the videos stored on the mobile phone. The used Samsung Galaxy S8 mobile phones run with the operating system Android 7.1.

The Gear 360 Action Director software (SM-C200) is used to process video sequences. The video sequences show

Table 1: Sequence of assessments at the different measurement times.

t_0 before starting the study	t_1 after 6 weeks	t_2 after 12 weeks	T_3 after 6 months
Parent information Declaration of consent „Nine Hole Peg Test" „Box and Block Test" „Movement-ABC-2 (manual dexterity)" „Timed-up & go" „Ten Meters Walking Test" „Goal Attainment Scale" „Six Minute Walking Test"	„Nine Hole Peg Test" „Ten Meters Walking Test"	„Nine Hole Peg Test" „Box and Block Test" „Movement-ABC-2 (manual dexterity)" „Timed-up & go" „Ten Meters Walking Test" „Goal Attainment Scale" „Six Minute Walking Test"	„Nine Hole Peg Test" „Box and Block Test" „Movement-ABC-2 (manual dexterity)" „Timed-up & go" „Ten Meters Walking Test" „Goal Attainment Scale" „Six Minute Walking Test"

Table 2: Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Children and adolescents aged 6-19 years	Children younger than 6 and adolescents older than 19 years
Diagnosis: Hemiparesis	
Knowledge of German language	
Written informed consent	

for example eating with both hands, playing the piano with both hands, tabletop soccer and pinball playing with both hands, playing table tennis with one hand as well as putting on pants and shoes and pulling back with both hands. In this first pilot study, standardized video sequences are used for all participants. Later, it is possible to provide a wide range of videos, which correspond to the needs and interests of the patients, via an internet platform to interested patients or experts, or to offer the possibility of uploading own videos.

During the intervention the parents of the study participants sit or stand close to the patient, in order to be able to give help in case of uncertainty. In adult stroke patients who receive intervention with VR glasses, it is recommended not to exceed the treatment time of 20 minutes [19]. For this reason, a treatment time per day of 15 minutes is not exceeded our children and adolescents with hemiparesis. More than 15 "treatments" seem to be necessary to demonstrate a positive effect [19]. There will be 84 interventions, each for 15 minutes in the 12 weeks. An option for the participants to report back their own needs and feedback to the study conductor is through weekly telephone calls with the families.

The statistical analysis will be performed with IBM SPSS© statistics 24.0.

Perspective

The study start is after the Hessen (Germany) summer holidays in August 2017 and first results are expected in winter 2017. The therapy with the VR-glasses takes place on top to the normal physiotherapy or occupational therapy.

Negative side effects are not expected, on the contrary: the researchers believe the children and adolescents accept the medium VR-glasses very well.

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