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Use of dynamic clothes in cerebral palsy rehabilitation: systematic review

Utilização de vestes dinâmicas na reabilitação da paralisia cerebral: revisão sistemática

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Abstract

Introduction: The intensive physical therapy program using dynamic clothing and elastic cords is an innovative approach in pediatric neurology physiotherapy area. **Objective:** To analyze the benefits of using dynamic clothes in intensive physical therapy protocols in patients with cerebral palsy. **Methods:** Electronic databases were used retrospectively without date restriction, in English, Portuguese and Spanish. The search focused on studies to document the use of intensive physical therapy protocols with the clothes on PC. **Results:** 14 studies were reviewed 6 narrative reviews, 1 systematic review, 6 clinical trials and one case study. It was not possible to group the results due to the diversity of protocols, the characteristics of the participants and the instruments used. **Conclusion:** All analysed studies reported improvement in gross motor control of patients, however, it is suggested the realization of double blind randomized and controlled clinical trials to prove the benefits of intensive physiotherapy programs with dynamic clothes.

Keywords: Exercise Therapy; Neurological Rehabilitation; Psychomotor Performance.

Resumo

Introdução: O programa de fisioterapia intensiva com a utilização de vestimentas dinâmicas e cordas elásticas é uma abordagem inovadora na área de fisioterapia neuropediátrica. **Objetivo:** analisar os benefícios da utilização dos trajes dinâmicos em protocolos de fisioterapia intensiva em pacientes com paralisia cerebral. **Método:** Foram consultadas bases de dados eletrônicas retrospectivamente, sem restrição de data, nos idiomas inglês, português e espanhol. A busca se concentrou em trabalhos que documentassem o uso de protocolos intensivos de fisioterapia com a vestimenta na PC. **Resultados:** Foram revisados 14 estudos, sendo 6 revisões narrativas, 1 revisão sistemática, 6 ensaios clínicos e 1 estudo de caso. Não foi possível realizar o agrupamento dos resultados devido à diversidade dos protocolos, das características dos participantes e dos instrumentos utilizados. **Considerações finais:** Todos os estudos analisados relataram melhora na motricidade grossa dos pacientes, entretanto, sugere-se a realização de ensaios clínicos duplo cegos randomizados e controlados para comprovação dos benefícios de programas de fisioterapia intensiva com trajes dinâmicos.

Descritores: Terapia por Exercício; Reabilitação Neurológica; Desempenho Psicomotor.

Introduction

Among the diseases that cause neuromotor deficits in childhood, non-progressive chronic encephalopathy, also known as cerebral palsy (CP) is one of the most frequent. The CP runs with sensory disorders, cognitive disorders, abnormal patterns of posture and movement, and changes in postural tone¹.

The child with neuromotor deficits uses compensatory mechanisms to overcome the force of gravity and get moving. Thus, the repetition in conducting such compensation creates muscle imbalances, deformity, stiffness, and loss of functionality². Having physical therapy in order to seek to promote and restore functionality, during the rehabilitation process is very important that the therapist keep the child in a proper postural biomechanical alignment³. This alignment facilitates the occurrence of voluntary movement in the closest possible to the standards as a typical, it promotes an adaptation in tonic activity⁴.

The literature reports some innovative protocols that seem to extend the functional rehabilitation possibilities of the patients with cerebral dysfunction and improve their quality of life⁵. As the intensive physical therapy program that uses clothing stabilized by a dynamic system of elastic cords, this dynamic costume performs corrections in biomechanical alignment that allow the learning of motor skills and gain muscle strength⁶.

The dynamic costume appeared in Russian research to develop a uniform that would prevent bone loss and muscle cosmonauts submitted to travel with absence of gravity⁷. From this, some have developed protocols intensive therapy using these dynamic garments such as Pediasuit the TheraSuit the PenguinSuit, and the AdeliSuit^{5,8}. These special garments are usually composed of: vest, shorts, knee pads and shoes, equipped with hooks and elastic cords that assist in positioning and alignment of body segments⁶.

In a search of the scientific literature found few studies that addressed intensive physiotherapy protocols in neuromotor rehabilitation child, because the use of dynamic clothing in PC rehabilitation is a new and innovative feature. Thus, this systematic literature review is to analyze the benefits of using dynamic clothes in intensive physiotherapy protocols used in CP patients.

Methods

In this systematic review, we consulted the electronic databases: MEDLINE, PEDro, Lilacs, SciELO, Scopus, Web of Science retrospectively without date restriction, using the keywords: *Therasuit, Pediasuit, Suit Therapy, Adeli Suit, Penguin Suit, Penguin Suit, PediaSuit, Neuro-Suit, PolishSuit and Dynamic Suit*. The search took place in English, Portuguese and Spanish. The last consult was conducted in January 2015.

Articles identified by the initial search strategy were evaluated independently by two authors, according to the following inclusion criteria: (1) population (individuals with CP), (2) intervention (rehabilitation with use of dynamic clothes). Articles in another language or who had repeated information available or other items were excluded. Such inclusion and exclusion criteria were applied when there was disagreement between the opinion of evaluators.

It previously selected 25 works by title content. After reading the abstracts, 11 were excluded for not meeting the inclusion criteria: 8 for being in Russian, 1 as it is medical equipment (not physical therapy), 1 because only possessed the summary available for analysis and one for being comment. So, 14 trials were included to step review (Figure 1).

The methodological quality assessment of the selected studies were conducted through PEDro scale, which rates trials with a score that ranges from 0 to 10 according to specific criteria⁹. This score was established after the analysis of two independent reviewers and the disagreements were solved by consensus after discussions. As the

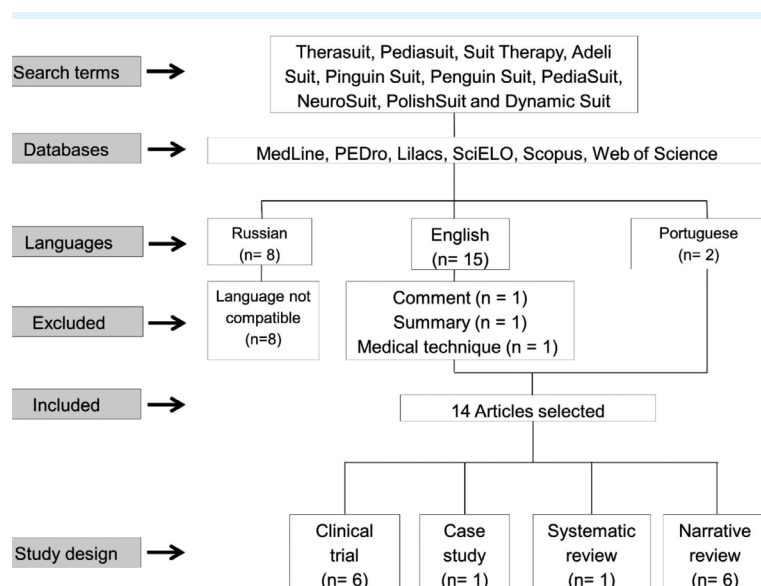


Figure 1: Flowchart of articles selection process

quality of reports of randomized controlled trials varies between subdisciplines of physiotherapy, in paediatric area the mean total PEDro score is 4.69¹⁰. Thus, this study considered that the papers with score upper than 5 had a high quality.

Results

The 14 articles included in this systematic review are presented in Tables 1 and 2. In these tables there are the main characteristics of each study. Tables 1 shows the result of the analysis of clinical trials^{7,11-15} and case study¹⁶, and Table 2 of narrative reviews^{3,6,17-20} and the systematic review⁵.

Characterization, Assessment and Intervention of Experimental Studies

The sample size of the selected experimental studies ranged from two to 94 children. In experimental studies there was only one case study¹⁶, and six clinical trials^{7,11-15}. Of those six clinical trials, four were randomized controlled^{7,12,13,14}, and, 2 without randomization and control group^{11,15}. In randomized studies, there were two blind ones^{12,14} and 2 with *follow-up*^{7,13},

one after 4 months¹³ and another, nine months after the end of the study⁷.

The common use of some assessment tools such as the Gross Motor Function Measure (GMFM) applied in six studies^{7,12-16} and the Gross Motor Function Classification System (GMFCS) in five studies, was observed^{7,13-16}. The Pediatric Evaluation Disability Inventory (PEDI) was mentioned in two studies^{14,15}. The electroencephalogram¹¹, the heart rate monitoring⁷, the three-dimensional gait analysis¹⁶, the *wi-fi* electrogoniometry¹⁵, and the analysis of parental satisfaction¹⁴ were cited in only one study.

The protocols are diverse and occur in a total of fifteen^{12,14,16}, twenty^{7,13} or twenty five¹⁵ sessions. The duration of each session varied from forty minutes¹¹ to four hours of intervention^{14,16} (some studies have used two^{7,12,13} or three¹⁶ hours of therapy). Intervention techniques contemplated since heating¹⁴⁻¹⁶, massage^{7,13-15}, stretching^{7,12,14-15} and muscular strength training¹²⁻¹⁶, up training of functional skills^{7,11-16}, osteopathy craniosacral¹⁵ and *kinesiotape*¹⁵.

In five studies there was explanation of some contraindications to the use of intensive physiotherapy with dynamic clothes, as spine fracture⁷, dislocation or subluxation of the hip^{7,13-15}, severe scoliosis^{7,13,14,16}, severe spasticity with contractures or other congenital deformities^{7,11,12}, epilepsy and neuromuscular dystrophies^{7,13}, systemic and cardiac disorders¹³. Some researches^{14,16} specify that the contraindication in subluxation occurs when the migration rate is above 35% and in case of scoliosis when the Cobb angle is greater than 25°.

Characteristics of Studies Review

Of the seven studies revision included for analysis in this study, six were narrative reviews^{3,6,17-20}, and 1 systematic review⁵. There was

Table 1: Description of the studies (clinical trials and case study) selected

| Author/ Year | Type | Participants | Aims | Tools | Intervention | Results | PEDro |
|--|---|--|---|---|---|---|-------|
| Semyonova ¹¹ , 1996 | Clinical Trial | 94 children with spastic diplegia | Motor control, walking and speech | Observation and EEG | 30 to 40 minutes | Acquisition of voluntary motor skills, walking improvement and dysarthria reduction | 2/10 |
| Bar-Haim et al. ⁷ , 2006 | Randomized controlled clinical trial with follow-up in 9 months | 24 children with spastic diplegia, triplegia and quadriplegia, and ataxic quadriplegia | Functional status and metabolic expenditure (climb stairs) | GMFCS, GMFM-66 and monitoring heart rate | 20 sessions: 5 days/week 4 weeks 2 hours/ day | Lower energy expenditure and improvement in functional status in Adeli Suit and Bobath Therapy Group. Children with higher GMFM had a better improvement in their energy expenditure | 6/10 |
| Jagatheesan ¹² et al., 2010 | Randomized controlled clinical blind trial | 30 children with spastic diplegia | Functional status | GMFM-88 | 15 sessions: 5 days/week 3 weeks 2 hours/day | Experimental group had superior improvement in GMFM than the control group with conventional physiotherapy | 4/10 |
| Mahani et al. ¹³ , 2011 | Randomized controlled clinical trial with follow-up in 4 months | 36 children with spastic diplegia and quadriplegia, and dystonia | Functional status | GMFCS, GMFM-66 | 20 sessions: 5 days/week 4 weeks 2 hours/day | Modified Adeli Suit Therapy Group obtained higher GMFM than Adeli Suit Therapy and Neurodevelopmental Treatment Groups | 6/10 |
| Bailes et al. ¹⁴ , 2011 | Clinical trial randomized blind controlled | 20 children with CP | Functional skills, caregiver assistance, functional status, perception of parents about comfort and improvement | GMFCS, PEDI, GMFM-66 and parental satisfaction assessment | 15 sessions: 5 days/week 3 weeks 4 hours/day | Experimental group improved their functional abilities and reduced the need for caregiver assistance. All parents reported some degree of discomfort and some were in doubt about the improvement | 7/10 |
| Neves et al. ¹⁵ , 2013 | Clinical Trial | 22 children with PC | Functional status and trunk control | GMFCS, GMFM-88, Wifi electrogoniometry | 25 sessions: 5 days/week 5 weeks 3 hours/day | Improvement in functional status and reduction in the trunk swing | 4/10 |
| Bailes et al. ¹⁶ , 2010 | Case Study | 2 children with diplegia | Functional skills, caregiver assistance, functional status, motor skills standing, walking, running and jumping | GMFCS, PEDI, GMFM (dimensions D and E), three-dimensional gait analysis | 15 sessions: 5 days/week 3 weeks 4 hours/day | Minimal changes and small reductions in functional abilities and in caregiver assistance. Minimal changes in motor skills to stand, walk, run and jump | 3/10 |

GMFCS= Gross Motor Function Classification System; GMFM= Gross Motor Function Measure; PEDI= Pediatric Evaluation of Disability Inventory.

no systematic review with meta-analysis of registration in searches carried out in databases. In narrative reviews it was found that four of them ranged various techniques and rehabilitation treatment described as alternative and complementary¹⁷⁻²⁰ and the intensive therapy protocol with dynamic garment has been classified and described as one of these techniques³.

Discussion

The studies used in this review are, except the narrative and systematic reviews, different in matter of the participant's profile, type of intervention and defining the outcome. However, many authors of systematic reviews tend to only communicate the positive results of clinical tri-

Table 2: Description of the selected revisions

| Author/ Year | Study Type | Aim | Results |
|-----------------------------------|-------------------|---|---|
| Rosembaum ¹⁷ , 2003 | Narrative review | Discuss difficulties to hit a treatment for CP and consider rules to analyze a new treatment | Briefly discusses various techniques, among them the Adeli Suit, which mentions only that the technique itself are controlled exercises against resistance (strengthening). |
| Liptak ¹⁸ , 2005 | Narrative review | Review 9 modalities of complementary and alternative therapies for children with CP. | The benefits of the technique are: muscle strengthening, posture and coordination improvement, increased sensory and proprioceptive information. |
| Oppenheim ¹⁹ , 2009 | Narrative review | Discuss 11 complementary and alternative methods of treatment of PC. | Includes some risks and benefits. Among them the Adeli suit therapy that has specific accessories and coupling the elastic cords able to offer strength and support to the movement. |
| Papavasilion ²⁰ , 2009 | Narrative review | Analyze the rehabilitation of orthoses, drug therapy, and complementary and alternative treatments for PC. | Describes Adeli Suit therapy benefits to strength and sensory feedback. Points out that the technique prevents osteoporosis, reduces ataxia and dysarthria, stimulates the vestibular system, improves mechanical efficiency, promotes gross motor skills gains, and that presence of a family member in intensive therapy bring engagement. |
| Scheeren ⁶ , 2012 | Narrative review | Describe the protocol PediaSuit TM to facilitate the occurrence of functional ability in patients with neurological disorders. | States that the protocol combines intensive physiotherapy with dynamic clothes up to 4 hours per day, five days a week for 3 or 4 weeks in 4 steps: heating and stretching, dynamic costume, "monkey cage" and "spider cage". Describes the interventions at each step and the components of the dynamic costume: vest, short, keepads, shoes, hooks and elastic cords. |
| Neves ³ , 2013 | Narrative review | Discuss the benefits of intensive physical therapy protocol with dynamic clothes. | Indicates resources for monitoring the results: AIMS, GMFM, GMFCS; force platform, wifi electrogoniometry, electromyography, mechanomyography and DEXA. Reported that this is a comprehensive approach that combines the best elements of several techniques. |
| Frangé ⁵ , 2012 | Systematic Review | Determine intensive physiotherapy using clothes with elastic benefits to neurological deficits. | There is insufficient evidence to support the clinic and that there is need for further studies involving dynamic clothes and intensive physiotherapy practice. |

AIMS= Albert Infant Motor Scale; PEDI= Pediatric Evaluation of Disability Inventory; GMFM= Gross Motor Function Measure; GMFCS= Gross Motor Function Classification System; DEXA= Dual-energy X-ray Absorptiometry.

Note: literature reviews found in this study are narrative reviews, addressing the subject broadly and without pre-established selection methodology, like book chapters^{21,22}.

als, that is, the results of interventions that took effect²³. It is also important to present the negative results of the studies and their limitations, since professionals, who are in the clinic, need this information to improve your practice²⁴. The heterogeneity in the samples of experimental studies reviewed did not allow a thorough comparative analysis.

It can be noticed that the intensive physical therapy protocols with dynamic garments are used in neurological patients, in order to

provide functional improvement, maintenance and reduction of motor deficits. This occurs through the stimulation of motor development, strengthening and muscle stretching⁵. These protocols are based on three principles: 1) the effect of clothing, generating load / resistive voltage applied to the muscles (muscle-building), increasing proprioception and biomechanical alignment (antigravity postures that organize tone); 2) intensive physical therapy training of motor skills (exercises with prolonged duration

and daily sessions over a period of a few weeks) and 3) the active participation of the patient motor (proposing activities of functional context)²⁵. The theory involving the benefits of using dynamic clothes is the occurrence of different proprioceptive sensory stimuli^{11,26}. Within this paradigm, the tonic-postural reorganization promotes learning and motor control suitable²⁷.

The review that there is no single form of technical application, as there are different protocols. There are variations in the number of hours per day, the total number of days and also used in the treatment management, making it impossible the comparison between the found intervention programs. It is noted that despite the absence of standards, all studies used pipes with a focus on functional training skills and 70% (5 studies) dedicated part of the intervention time massage^{7,11-13,16} and stretching exercises^{7,12,14-16} and strengthening¹²⁻¹⁶. In addition, one study showed a more complete protocol covering all lines of other studies and included the application of craniosacral osteopathy and Kinesiotape¹⁵.

Some of the reviewed studies refers to the intensive therapy protocol with dynamic clothes as a complementary and alternative technique¹⁷⁻²⁰. Others also shows that different classifications are used to refer to the protocols as Therasuit, Pediasuit, Suit Therapy, Adeli Suit and Intensive Therapy Neuromotor (TNMI)¹⁵.

The analysed experimental studies employed with great frequency instruments such as the GMFM (85%) and the GMFCS (70%) to measure the evolution of patients, but the rating scales are subjective and its reliability could be increased in the existence of a double blind review. Another instrument used in 30% of studies was the PEDI scale in which parents or caregivers are the informants and are responsible for the participant, a fact that also increases the subjectivity of the results.

It would therefore be of great value the use of objective tools and the measurement of the elastic tension and standardization in its positioning for attesting the intensive protocol efficiency and clothes. Despite the good quality of

the studies, the results shows few effectiveness when compared to conventional techniques, as found in other systematic reviews about rehabilitation^{28,29}. This fact suggests de necessity of more studies in this area.

Conclusion

The intensive physiotherapy protocol associated with the use of dynamic clothes in PC is a promising feature that still needs investigation. Due to lack of standardization in the methodology of the studies conducted so far, it is difficult to say precisely what are the benefits of the technique and if these are superior to other techniques. There was the emergence of a name with a focus on technical methodology, Intensive Therapy Neuromotor (TNMI) encompassing the intensive physical therapy protocols using dynamic clothes and conventional rehabilitation techniques.

It was verified the influence potential of the technique on the evolution of the motor capacity in neuropsychiatric patients, which indicates the need for the realization of double blind randomized and controlled clinical trials, and studies with similar goals and methodologies for allow researchers to conducting meta-analysis in order to conclude if dynamic clothes rise the gains in therapy or not.

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