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Cerebral palsy: Influence of TheraTogs® on gait, posture and in functional performance

Paralisia cerebral: Influência do TheraTogs® na marcha, postura e no desempenho funcional

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Abstract

Introduction: For children with cerebral palsy, orthoses take an important role in improving posture, gait, functional performance and preventing secondary musculoskeletal disorders. **Objective**: To evaluate the influence of TheraTogs® on the posture, distribution of plantar pressure during gait and functional performance of a child with spastic diplegia cerebral palsy. **Methods**: A quantitative evaluation was carried out on a case study in which an 11-year-old child diagnosed with diplegic cerebral palsy underwent postural assessment through the Postural Assessment Software (PAS), plantar pressure distribution assessment during barefoot gait through the Emed-X system, before and after the intervention period of 8 weeks and functional assessment (Pediatric Evaluation of Disability Inventory - PEDI), with and without TheraTogs®. **Results**: In posture, TheraTogs® had greater influence on hip extension and this change was greater during its use. In the plantar pressure distribution assessment, an increase in posteriorization of plantar pressure occurred in the initial contact, the performance of the push-off phase and initial swing phase improved. In functionality, the child showed improvements in mobility, however, their self-care ability with TheraTogs® was reduced. **Conclusion**: Although improvements in posture, gait and functionality were verified with the

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use of TheraTogs®, the excessive heat, difficulties in toileting and self-care were disadvantages in wearing TheraTogs®.

Keywords: Cerebral Palsy. Posture. Gait. Orthotic Devices.

Resumo

Introdução: *Para crianças com Paralisia Cerebral as órteses assumem um papel importante na melhora da postura, da marcha, do desempenho funcional e na prevenção de problemas musculoesqueléticos secundários.* ***Objetivo****: Avaliar a influência do TheraTogs® na postura, na distribuição de pressão plantar durante a marcha e no desempenho funcional de uma criança com paralisia cerebral do tipo diplegia espástica.* ***Métodos****: Trata-se de uma avaliação quantitativa em um estudo de caso, no qual uma criança de 11 anos de idade e diagnóstico de Paralisia Cerebral do tipo diplegia espástica foi submetida à avaliação postural, através do Software de Avaliação Postural (SAPO), avaliação da distribuição de pressão plantar durante a marcha descalça, através do sistema Emed-X, antes e depois do período experimental de 8 semanas, e avaliação da funcionalidade, através do Inventário de Avaliação Pediátrica de Disfunção (PEDI), sem e com TheraTogs®.* ***Resultados****: Na postura o TheraTogs® teve maior influência na extensão do quadril e essa alteração foi maior na utilização imediata. Na distribuição de pressão plantar ocorreu aumento da posteriorização da pressão plantar no contato inicial, melhorou o desempenho na fase de impulsão (desprendimento do pé do solo) e na fase do balanço da marcha. Na funcionalidade a Criança obteve ganhos na área de mobilidade, no entanto, sua capacidade de autocuidado com o TheraTogs® foi reduzida.* ***Conclusão****: Embora observadas melhoras na postura, na marcha e na funcionalidade com o uso do TheraTogs®, o calor excessivo e dificuldades no acesso ao toalete e no autocuidado foram pontos de desvantagem na utilização do TheraTogs®.*

Palavras-chave: *Paralisia cerebral. Postura. Marcha. Órtese.*

Introduction

In 2006, the Executive Committee of the International Workshop formulated a definition that describes cerebral palsy (CP) as a group of permanent disorders of the development of posture and movement, attributed to non-progressive disturbances in fetal or child development. The motor disorders caused by cerebral palsy, generally, are associated with language, cognitive, sensory, perceptual and behavioral changes, in addition to epilepsy and secondary musculoskeletal problems (1). The muscle shortening and deformities (secondary musculoskeletal problems) in CP children are due to biomechanical misalignment during motor development stages and daily-life activities and cause pain, loss of mobility and compromise the locomotor system, increasing susceptibility to surgical interventions (1 - 6).

In this sense, orthoses play an important role in the treatment of CP children and are recommended for the support of a body segment or for inhibiting involuntary movements. The objective of the orthoses is to increase the function, prevent deformities and contractures, keep the extremities at a functional position, aid in the function of weak muscles and facilitate the selective motor control (7). However, orthoses can be fixed, made of rigid materials, operating in positioning the segment and muscle length passively, or they can be dynamic and besides positioning the segment they may allow for active user participation in the movement, providing mobility and improvement in the muscle function during gait (8, 9), for instance.

The use of flexible dynamic orthotic garments, such as TheraTogs®, has been suggested to improve the ability to stabilize the posture, to correct or prevent deformities, improve functionality and to enable the user a more appropriate functional pattern (10 - 17). However, studies have shown that aspects such as the lack of practicality, difficulties in the toilet tasks, discomfort and the heat caused by this type of orthesis, hinder adhesion and adaptation to use (11 - 15).

TheraTogs®, the object of this study, is a dynamic orthotic garment, which, according to the manufacturer, is composed of a 'breathable', light, Velcro-adhesive fabric. This garment was developed to provide a smooth passive strength, to correct imbalances or alignments through a combination system of trunk and lower limbs, along with a system of custom outer straps (18).

The use of orthopedic garments in PC children lack scientific evidence to contribute to the decision making in health practices (19). Thus, the objective of this study is to evaluate the influence of TheraTogs® on posture, plantar pressure distribution during gait and functional performance of a child with spastic diplegia cerebral palsy, contributing to strengthen the scientific scope on the subject.

Methods

An 11-year-old child with a clinical diagnosis of CP, female, height of 1.29 m, body mass of 33.05 kg and BMI of 19.86 Kg/m^2. Clinical evaluation showed spasticity with topographical setting of muscle tone changes in diplegia and gross motor at level II, according to the Gross Motor Function Classification System (GMFCS).

In the assessment of the motor patterns the following changes were observed: the child has difficulties in postural changes; being able go from the prone position to supine position with moderate difficulty; and from a lying position (prone or supine) to sitting and from sitting to standing using the upper limbs; the subject does not go through a semi-kneeling position to get to the standing posture; when sitting on the floor, she is positioned on the sacrum and when her legs are extended the thoracic kyphosis increases; when standing, the subject presents scoliosis, with convexity to the right side and has poor balance reactions, especially the ankle reaction, using the hip or step reaction as strategies in trying to seek balance. The subject cannot maintain balance with unilateral support for longer than 1 second (greater difficulty on the right); front, back and side reactions are present; standing and during gait she presents internal rotation of the lower limbs (more pronounced on the right), hip flexion and knee (more pronounced on the right), valgus knees, rotating on her own axis to the left; the subject transfers most of the body weight to her left leg; presents previous body projection in relation to the gravity center during gait and does not perform all the gait phases, being the initial contact made with the forefoot and maintained predominantly throughout the stance phase. The subject presents equinovalgus feet (more pronounced on the right), collapse of the plantar arch and valgus hallux, predominantly on the right; difficulties in locomotion in environments with uneven ground, requiring the support of another person; and slow gait speed.

This study was approved by University Feevale-RS ethics committee on human research (02610112.7.0000.5348). Informed consent was signed by the child's guardian, as per Resolution 196/96.

This study used the Full Body TheraTogs® system (orthoses) (Figure 1), consisting of vest and shorts with straps (outer straps customized system) to facilitate trunk extension, reduce shoulder protraction, stimulate lower abdomen proprioception, facilitate external rotation and hip extension.

In this study, after a period of gradual adaptation to the orthosis (one week- two or more hours, depending on tolerance), the child wore the orthosis for eight weeks, from 8 to 10 hours a day, during daily-life activities. The child's guardian (mother) was trained and received a DVD recording, with a step-by-step demonstration on the fitting of TheraTogs® in the child. Markings were made in TheraTogs® to facilitate and improve fitting. All necessary support was offered, with weekly monitoring in person to control the fitting of the orthesis, as well as for possible questions or clarifications.

The Postural Assessment Software (PAS) was used for postural assessment, with and without TheraTogs® before and after the intervention period to establish and document the main changes related to the static posture of the child. The marked points followed the PAS protocol (20) and the C = child was assessed on the left and right side (Figure 1C). The following angles were used in the analysis: Trunk inclination: angle between the greater trochanter and the acromion and the vertical line; Hip angle: angle between the anterior superior iliac spine, greater trochanter of the femur and joint line of the knee; Knee angle: angle between the greater trochanter of the femur, joint line of the knee and lateral malleolus; and Ankle angle: angle between the joint line of the knee, lateral malleolus and head of the second metatarsal bone.

Data on the plantar pressure distribution was obtained during barefoot gait, by using a pressure platform (Emed X-Novel, GbmH) with capacitive sensors at a resolution of 4 sensor/cm^2, and at an acquisition rate of 100 Hz. Plantar pressure data during barefoot gait, were processed by using the Software Novel (21). The plantar pressure distribution outcomes measured in this study, according NOVEL (21) were: peak plantar pressure (PPP); total contact time (TCT) and total contact area (TCA).

During the collection of data on the plantar pressure, the child walked barefoot at self-selected speed, for a distance of approximately 5 meters. Five repetitions were considered valid (feet inside the floor area of Emed-X platform). After the adjustment period with the orthosis, four plantar pressure assessments were carried out during gait: *pre-test1* - without the orthosis (PRE1) and *pre-teste2* - with the orthosis (PRE2), carried out before the intervention period; *post-test1* - without the orthosis (POST1) and *post-test2* - with the orthosis (POST2), performed after the intervention period.

The Pediatric Evaluation for Disability Inventory (PEDI) (22) was applied for assessing functionality with and without the orthosis. PEDI uses the scaled scores of the three scales for functional skills (Part I) and the three scales for caregiver assistance (Part II) as assessment baselines. In addition, after the intervention period, an interview with the child's guardian was applied, which addressed five issues regarding the perception of responsibility in relation to comfort, practicality and acceptance of the orthosis by the child. During the intervention period a diary was used to record the time of use of the orthosis.

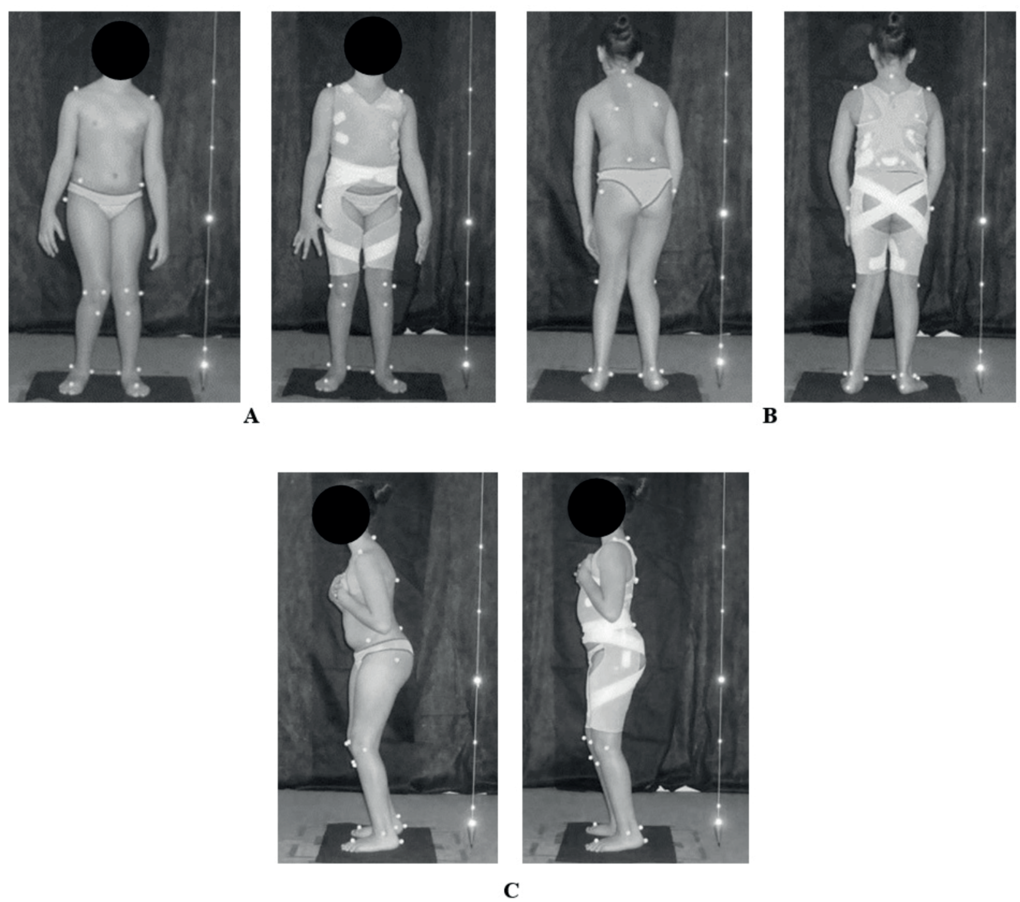


Figure 1 - Child's posture without TheraTogs® and with TheraTogs®, in front view (A), back view (B) and left side view (C)

Data analysis

Means and standard deviations were presented for data on the postural assessment and plantar pressures. The means between the situations (PRE1 and PRE2, POST1 and POST2) were compared in percentage terms.

PEDI data were analyzed according to the scaled scores of the three scales for functional skills (Part I) and the three scales for caregiver assistance (Part II) (22).

Results

Data on the postural assessment of the child (Table 1) on the right side and left planes are presented in degrees and compared in percentages for assessments with and without TheraTogs® before the intervention period (PRE1, PRE2) and after the intervention period (POST1- POST2; PRE1- POST1; PRE2- POST2).

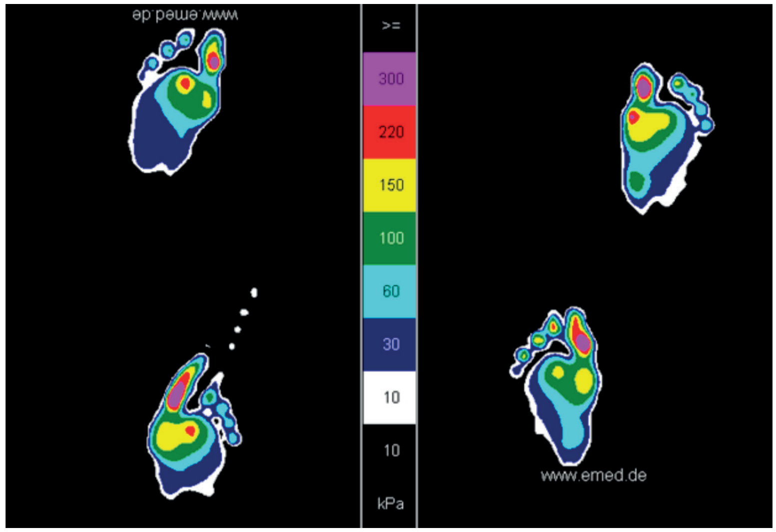
Figure 2 shows the plantar pressure distribution during the gait of the child, with and without TheraTogs®, in the assessments before and after the intervention period. We found that he use TheraTogs® contributed to the posteriorization of plantar support, especially after the intervention period (POST2), in which contact in the midfoot region (POST1 and POST2) and hindfoot region (heel) (POST2) increased. In addition, with TheraTogs® both before (PRE2) and after the intervention period (POST2), there was no contact of the right hallux in the swing phase when using the pressure platform as noted in PRE1 (Figure 2A). Furthermore, after the intervention period we did not observe contact of the hallux, after the intervention period, without TheraTogs® (POST1).

Table 2 presents data on plantar pressure outcomes (pressure peaks Planting Contact Total Area and Total Dwell Time) during gait with and without TheraTogs® in evaluations before and after the intervention period. Plantar pressure peaks for the feet (left and right) were presented relating to the regions of the hindfoot (heel), midfoot, forefoot (metatarsals) and hallux (Table 2). The use of TheraTogs® for 8 weeks (POST1 and POST2) caused increased plantar pressure peaks in the midfoot and hindfoot regions, thus showing a posteriorization of the plantar support. We also highlight immediate changes (PRE2) caused by TheraTogs®, with increased pressure peaks in the midfoot region (Table 2).

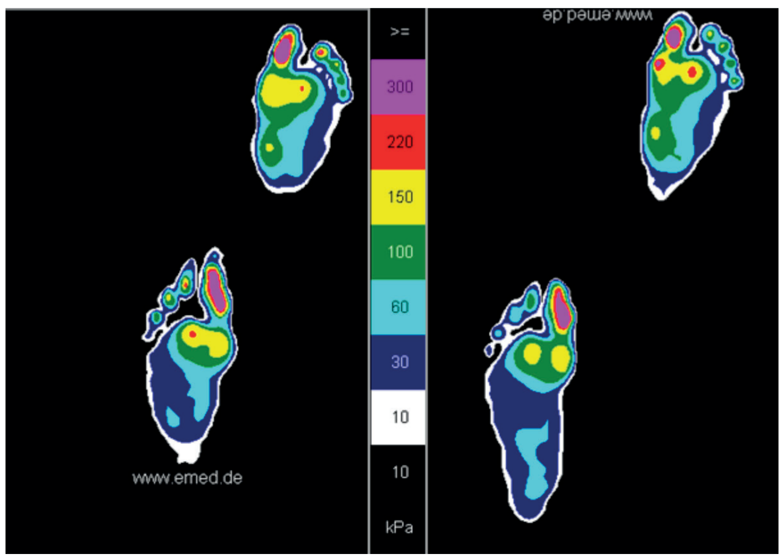
Table 1 - Data for postural assessment (in degrees and percentages)

Assessment Joint Angle	PRE1		PRE2		POST1		POST2	
	LS	RS	LS	RS	LS	RS	LS	RS
Trunk extension (°)	159	166	178	177	167	169	171	175
Hip extension (°)	104	117	141	147	118	133	129	130
Knee extension (°)	148	145	160	154	143	147	155	150
Ankle angle (°)	88	86	89	84	85	87	85	84
Assessment Joint Angle	**PRE1-PRE2**		**POST1-POST2**		**PRE1-POST1**		**PRE2-POST2**	
	LS	**LS**	**LS**	**RS**	**LS**	**RS**	**LS**	**RS**
Trunk extension (%)	12	7	2	4	5	2	-4	-1
Hip extension (%)	36	26	9	-2	13	14	-8	-12
Knee extension (%)	8	6	8	2	-3	1	-3	-3
Ankle angle (%)	1	-2	0	-3	-3	1	-4	0

Note: PRE1(before intervention period-without TheraTogs®); PRE2 (before intervention period-with TheraTogs®); POST1 (after intervention period-without TheraTogs®) e POST2 (after intervention period-with TheraTogs®). LS-Left Side; RS-Right Side. +values =increase in extension/angle; - values =decrease in extension/angle.



A) PRE1- without TheraTogs® B) PRE2- with TheraTogs®



C) POST1- without TheraTogs® D) POST2- with TheraTogs®

Figure 2 - Plantar pressure distribution, with and without TheraTogs®, in assessments before and after the intervention period

As to the total contact area (ACT), before the intervention period (PRE1), a difference of approximately 10% between the left foot and the right foot (Table 2) was observed, such difference is related to the asymmetries observed in the postural assessment (Table 1). After the 8-week intervention period (POST1), the TheraTogs® caused the transference of the body weight to the right side, increasing TCA and decreasing asymmetry between the right and left feet (≅5%). We also found that after 8 weeks of use of TheraTogs® (POST2) changes continue to be seen as to the plantar pressure distribution during gait, increasing the TCA for the left foot (Table 2).

In addition, we found that the use of TheraTogs® (PRE2 and POST2) caused an average increase of 18% in the total contact time (TCT) after the intervention period. In the evaluations without TheraTogs® (PRE1 and POST1) we did not observe changes in the TCT during gait.

Regarding the functionality (PEDI) in the area of mobility, in the functional skills domain, the child showed an improvement of 8% in the scaled score.

In the caregiver assistance domain, the functionality score increased by 13%, with less aid needed when the child wore TheraTogs® (Table 3). In the self-care domain, as to the functional skills, no changes were detected. However, in the caregiver assistance domain, the child's scaled score of 30% decreased, and more help was required for the tasks. There were no differences in the child's score in both areas related to the social function with and without the orthosis (Table 3).

Along with functional assessment results, the child's mother reported that the lack of practicality for fitting and removing the TheraTogs® due to the large number of velcro straps attached to the orthosis turned the child more dependable in activities such as changing clothes and accessing the toilet, making the child more likely to urinate and evacuate on their own clothes. Furthermore, the mother reported that the orthosis caused a lot of heat during its use.

Table 2 - Data on the plantar pressure distribution during gait

	Plantar Pressure Outcomes (average±standard deviation)				
Assessment	**Foot**	**PRE1**	**PRE2**	**POST1**	**POST2**
Contact Area (cm²)	Left	74.2 ± 5.6	78.1 ± 9.5	72.7 ± 12.7	97.5 ± 6.6
	Right	66.7 ± 3.3	65.6 ± 9.0	76.6 ± 11.0	75.3 ± 9.4
Total Contact Time (ms)	Left	676.7 ± 45.1	682.5 ± 57.4	671.7 ± 38.7	797.5 ± 151.7
	Right	713.3 ± 25.2	662.5 ± 55.6	718.3 ± 41.7	788.8 ± 123.8
Pressure Peaks (kPa) – Regions of the foot (average values)					
Forefoot	Left	*wp*	*wp*	17 ± 6	47 ± 6
	Right	*wp*	*wp*	*wp*	*wp*
Midfoot	Left	56 ± 8	74 ± 12	64 ± 11	79 ± 10
	Right	90 ± 39	142 ± 18	134 ± 43	118 ± 40
Hindfoot	Left	257 ± 37	235 ± 25	262 ± 50	233 ± 45
	Right	287 ± 16	291 ± 46	307 ± 73	329 ± 70
Hallux	Left	556 ± 76	662 ± 96	575 ± 161	574 ± 184
	Right	907 ± 55	839 ± 120	865 ± 97	886 ± 109

Note: PRE1(before intervention period-without TheraTogs®); PRE2 (before intervention period-with TheraTogs®); POST1 (after intervention period-without TheraTogs®) e POST2 (after intervention period-with TheraTogs®). *wp* =without pressure peaks.

Table 3 - Comparative data on the composed scores of PEDI questionnaire, in the assessments before (PRE1) and after the intervention period (POST2)

		PRE1			POST2		
Domain	**Area**	**Raw Score**	**Scaled Score**	**Standard Error**	**Raw Score**	**Scaled Score**	**Standard Error**
Functional Skills	Self-care	**73**	--------	--------	**72**	--------	--------
	Mobility	51	59.24	2.40	55	63.94	2.66
	Social Function	**63**	**100.00**	**10.13**	**63**	**100.00**	**10.13**
Caregiver Assistance	Self-care	45	--------	--------	27	69.98	3.39
	Mobility	**32**	**81.30**	**6.57**	**34**	**92.32**	**13.86**
	Social Function	24	89.02	9.91	24	89.02	9.91

Note: -------- = score higher than the minimum scaled score 100 from the reference table for the item, depicting a superior performance in the assessed area (22).

Discussion

In the postural assessment of the child we observed that the use of TheraTogs® caused an increase in the hip extension that reflected in the trunk and knee extension, which is consistent with what was found by Abd El-Kafy (16). The changes were more pronounced in the evaluation before the intervention period (PRE1 and PRE2) than after the intervention period (POST1 and POST2), thus characterizing immediate changes with the use of TheraTogs® (PRE2). The magnitude of the postural changes was lower after the 8-week intervention period with TheraTogs®. This fact may be related postural adaptations caused by the wear of the orthosis and/or a decrease in tension/resistance of the straps due to its use.

No significant changes were observed in the child's knees and with the use of the orthosis (PRE and POST), given that the orthosis does not act directly in these joints. Furthermore, the changes that occurred in the knee are due to repositioning of the hip. In addition, the fact that the influence of the orthosis was higher on the left side of the body may be related to the child's clinical data. In this sense, in the standing position and during gait the child presents internal rotation of the lower limbs, more pronounced hip and knee flexion on the right and rotation on her own axis to the left, transferring most of the body weight to the lower left limb. In POST2, in which the changes were greater in the right hip, we noticed that the child transferred the body weight to the lower right limb, unlike observed at baseline (PRE1).

Abd El-Kafy (16) studied the clinical impact of ground reaction orthoses and TheraTogs® in gait parameters of children with spastic diplegia cerebral palsy. For this purpose, a sample of 56 children was divided in three groups: GROUP A- this group underwent neurodevelopmental therapy, including gait training and orthostatism without orthopedic intervention; GROUP B- this group performed the same therapy as GROUP A and wore TheraTogs®; GROUP C- this group underwent the same procedures as GROUP B, associated with the use of ground reaction orthoses. The results of the study showed that the use of TheraTogs® and the ground reaction orthoses increased plantar flexion, knee and hip extension during the stance phase. In addition, speed, pace, and stride length were also increased. As for the GROUP B, significant changes appeared only in increased hip extension and stride length. GROUP A had an increase in hip and knee extension and an increase in speed, pace and length of the stride along the treatment. However, these changes were not statistically significant.

A pattern of back plantar support was observed in the analysis of the plantar pressure distribution behavior during the gait before the intervention period (PRE1 without TheraTogs®), in which the initial contact during the gait, for both feet, was performed with the forefoot. This is a change commonly found in the gait of children with cerebral palsy spastic diplegia (23, 24).

The use of TheraTogs® caused changes in gait, with a posteriorization of the plantar support, increasing the contact of the heel and reducing the contact area of the hallux on the swing phase and especially in the swing phase, in which, in conditions in which there are no neuromusculoskeletal changes, the foot has no contact with the ground (3, 25).

Similar to what was evidenced by Nsenga Leunkeu et al. (26) as to the plantar pressure distribution in children with spastic diplegia PC, in this study we found that the highest plantar pressure peaks occur in the hallux region and in the head of the metatarsals, showing a medial/central pattern, i.e., shifting the load to the medial head of the metatarsals (metatarsal I and metatarsal II), to the left foot and to the right foot. The results relating to the pressure peaks in this study can be associated with the postural assessment data and to observations during the clinical assessment, in which we observed anterior movement of the body in relation to the vertical axis and internal rotation of the lower limbs.

We observed that the position of pelvic anteversion, associated with the semiflexion of hip and knee, the medial knee projection (valgus), valgus ankle and flat feet, in clinical and postural assessment and commonly described in the literature on PC children (4, 23, 27 - 29), have contributed to a shift in the gravity center. This change directly reflected in the plantar pressure distribution on the support base, the feet, causing the anterior plantar support and the medial/central plantar pressure distribution pattern observed in PRE1. The postural asymmetries that were detected collaborate to the lack of uniformity in the plantar pressure distribution pattern between the feet, left and right. In PRE2, the posture imposed by TheraTogs® caused a posteriorization of the plantar pressure, yet, the behavior is still different from the normal pattern shown by healthy children of the same age (30), as we did not observe support in the entire plantar region during gait.

The analysis of the plantar pressure peaks showed that it did not occur in the appropriate areas. The peaks were high in the hallux region, low in the midfoot region and metatarsals and absent in the heel region (30, 31) in both feet. Gaston et al. (27) found a correlation between the rotation of the foot and of the hip and pelvis, showing that when the foot receives the load medially, the entirety of the lower limb rotates inward. This finding is in consonance with the findings in this study, in which we observed medial support in the foot and internal rotation of the lower limbs. According to the authors (27), this is due to the lever arm dysfunction as a result of the shortened leg and inefficiency plantar flexion and knee extension.

TCA values found in this study in PRE1 were close to the values reported as normative for the left foot, but lower as to the right foot, for children with an average age of nine years old (32). These findings can be explained by the pronounced support seen in the midfoot region (plantar arch), which features a flat foot with valgus ankle characteristic in CP children (3).

The total contact time is inversely proportional to the gait speed, and the higher gait speed found in CP children is often related to the lack of control and balance. Thus, in this study, the highest TCT, with the use of TheraTogs® in POST2, may be an indication of improvement in the control and balance during gait. Some studies (12, 17) also showed improvements in the functional and balance patterns during gait with the use of TheraTogs®. In the investigation proposed by Flanagan et al. (12) similar to that observed in this study, in general, children marched with a gait pattern with initial contact made by the forefoot, featuring a pattern of 'jump gait'. According to the kinematic profile, an anterior displacement of the pelvis and a decreased hip extension peak was observed in the stance phase. After 8 weeks of intervention with TheraTogs®, the authors observed significant differences in the hip extension peak and pelvic alignment. The post-intervention kinematic data on gait showed that the hip extension peak in the terminal stance increased during the period using the orthosis (TheraTogs®) and did not return to baseline as per the follow-up 2 and 4 months after. The pelvic alignment in a lateral plane, however, was only affected when the TheraTogs® was being worn, causing a more posterior pelvic displacement during the stance and swing stages.

In this study, the changes imposed by TheraTogs® in the child's posture and gait were also detected in the functionality, in the mobility area, of the two domains of PEDI questionnaire (functional skills and caregiver assistance), as reported in the literature (12). This gain happened due to an increase in the repertoire of the following functional activities: indoor locomotion: distance/speed, moving from one room to the other without difficulty; locomotion in the external environment: methods, walk without support; when climbing stairs, climb a set of stairs without difficulty and when going down stairs, do it without difficulties.

In contrast, the PEDI showed that the child lost independence in various tasks with the use of TheraTogs®, requiring maximum assistance when wearing the upper and lower body parts, moderate assistance in using the bathroom and minimal assistance in urinary control. On the other hand, without TheraTogs® the child had acquired complete independence in these tasks. Problems such as loss of independence in toilet tasks and difficulties in handling orthopedic garments are commonly reported (12 - 15) and the vulnerability in urinating and evacuating in the orthopedic garments due to lack of practicality (delay in fitting and removing) has also been documented (15). Moreover, the heat caused by the use of TheraTogs® is another disadvantage factor evidenced in this study, in consonance to what has been reported in the literature on this type of orthoses (12 - 15), regardless of being been used in a period with lower temperatures (transition between winter and spring), which can infer major changes when used in hot places or times of the year with higher temperatures.

Conclusions

Finally, the results of this study reveal that with the use of TheraTogs® some changes in posture were observed, mainly related to the hip extension, plantar pressure distribution, with increased posteriorization of the plantar pressure, of the contact area and total contact time, and of the functionality in the mobility aspect. Despite these changes, the excessive heat, the difficulties in accessing the toilet, in dressing and related to bladder control, were disadvantageous points in the use of TheraTogs®. We observed that the combination of the use of TheraTogs® with suropodalic-type orthoses or insoles could leverage changes in the plantar pressure distribution, considering the flat feet characteristic, with pronation of the calcaneus, often observed in children with cerebral palsy.

We suggest further research with a higher numbers of subjects and experimental studies to evaluate the influence of the use of TheraTogs® in children with cerebral palsy, in the short, medium and long term. In addition, we suggest studies related to the ideal daily use time of TheraTogs®.

References

1. Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M, Damiano D, et al. A report: the definition and classification of cerebral palsy April 2006. Dev Med Child Neurol Suppl. 2007;109:8-14.
2. Cury V, Mancini M, Melo APP, Fonseca ST, Sampaio RF, Tirado MGA. Efeitos do uso de órteses na mobilidade funcional de crianças com paralisia cerebral. Rev Bras Fisioter. 2006;10(1):66-73.
3. Gage JR, Novacheck TF. An update on the treatment of gait problems in cerebral palsy. J Pediatr Orthop B. 2001;10(4):265-74.
4. Carriero A, Zavatsky A, Stebbins J, Theologis T, Shefelbine SJ. Correlation between lower limb bone morphology and gait characteristics in children with spastic diplegic cerebral palsy. J Pediatr Orthop. 2009;29(1):73-9.
5. Ward KA, Caulton JM, Adams JE, Mughal MZ. Perspective: cerebral palsy as a model of bone development in the absence of postnatal mechanical factors. J Musculoskelet Neuronal Interact. 2006;6(2):154-9.
6. Hicks JL, Schwartz MH, Arnold AS, Delp SL. Crouched postures reduce the capacity of muscles to extend the hip and knee during the single-limb stance phase of gait. J Biomech. 2008;41(5):960-7.
7. Mattacola CG, Dwyer MK, Miller AK, Uhl TL, McCrory JL, Malone TR. Effect of orthoses on postural stability in asymptomatic subjects with rearfoot malalignment during a 6-week acclimation period. Arch Phys Med Rehabil. 2007;88(5):653-60.
8. Papavasiliou AS. Management of motor problems in cerebral palsy: a critical update for the clinician. EJPN. 2009;13(5):387-96.
9. Jozefczyk PB. The management of focal spasticity. Clin Neuropharmacol. 2002;25(3):158-73.
10. Blair E, Ballantyne J, Horsman S, Chauvel P. A study of a dynamic proximal stability splint in the management of children with cerebral palsy. Dev Med Child Neurol. 1995;37(6):544-54.
11. Ehlert R. A influência da utilização de um sistema de vestuário ortopédico dinâmico flexível na marcha e no desempenho funcional de crianças com paralisia cerebral [master´s thesis]. Novo Hamburgo (Brazil): Universidade Feevale; 2013. Portuguese.
12. Flanagan A, Krzak J, Peer M, Johnson P, Urban M. Evaluation of short-term intensive orthotic garment use in children who have cerebral palsy. Pediatr Phys Ther. 2009;21(2):201-4.
13. Matthews MJ, Watson M, Richardson B. Effects of dynamic elastomeric fabric orthoses on children with cerebral palsy. Prosthet Orthot Int. 2009;33(4):339-47.
14. Nicholson JH, Morton RE, Attfield S, Rennie D. Assessment of upper-limb function and movement in children with cerebral palsy wearing lycra garments. Dev Med Child Neurol. 2001;43(6):384-91.
15. Rennie DJ, Attfield SF, Morton RE, Polak FJ, Nicholson J. An evaluation of lycra garments in the lower limb using 3-D gait analysis and functional assessment (PEDI). Gait Posture. 2000;12(1):1-6.
16. Abd El-Kafy EM. The clinical impact of orthotic correction of lower limb rotational deformities in children with cerebral palsy: a randomized controlled trial. Clin Rehabil. 2014;28(10):1004-14.
17. Maguire C, Sieben JM, Frank M, Romkes J. Hip abductor control in walking following stroke — the immediate effect of canes, taping and TheraTogs on gait. Clin Rehabil. 2010;24(1):37-45.
18. Cuzick B. TheraTogsTM-the live-in orthotics system you've been waiting for! 2012 [cited Jan 5 2013]. Available from: http://tinyurl.com/z27d6q3.
19. Coghill JE, Simkiss DE. Question 1. Do Lycra garments improve function and movement in children with cerebral palsy? Arch Dis Child. 2010;95(5):393-5.

20. Ferreira EA, Duarte M, Maldonado EP, Burke TN, Marques AP. Postural assessment software (PAS/SAPO): Validation and reliabiliy. Clinics. 2010;65(7):675-81.

21. Novel GmbH. Manual Novel Windows Software. Version 9.3 Germany; 2001. 80 p.

22. Mancini MC. Inventário de avaliação pediátrica de incapacidade (PEDI). Manual da versão brasileira adaptada. Belo Horizonte (Brazil): UFMG; 2005. Portuguese.

23. Rodda J, Graham HK. Classification of gait patterns in spastic hemiplegia and spastic diplegia: a basis for a management algorithm. Eur J Neurol. 2001;8 Suppl 5:98-108.

24. Rodda JM, Graham HK, Carson L, Galea MP, Wolfe R. Sagittal gait patterns in spastic diplegia. J Bone Joint Surg Am. 2004;86(2):251-8.

25. Perry J. Análise da marcha. São Paulo: Manole; 2005. Portuguese

26. Nsenga Leunkeu A, Lelard T, Shephard RJ, Doutrellot PL, Ahmaidi S. Gait cycle and plantar pressure distribution in children with cerebral palsy: clinically useful outcome measures for a management and rehabilitation. NeuroRehabilitation. 2014;35(4):657-63.

27. Gaston MS, Rutz E, Dreher T, Brunner R. Transverse plane rotation of the foot and transverse hip and pelvic kinematics in diplegic cerebral palsy. Gait Posture. 2011;34(2):218-21.

28. Richards A, Morcos S, Rethlefsen S, Ryan D. The use of TheraTogs versus twister cables in the treatment of in-toeing during gait in a child with spina bifida. Pediatr Phys Ther. 2012;24(4):321-6.

29. Bobath B. Motor development, its effect on general development, and application to the treatment of cerebral palsy. Physiotherapy. 1971;57(11):526-32.

30. Bosch K, Gerss J, Rosenbaum D. Development of healthy children's feet--nine-year results of a longitudinal investigation of plantar loading patterns. Gait Posture. 2010;32(4):564-71.

31. Chang HW, Chieh HF, Lin CJ, Su FC, Tsai MJ. The relationships between foot arch volumes and dynamic plantar pressure during midstance of walking in preschool children. PloS One. 2014;9(4):e94535.

32. Klavdianos ACD, Manfio EF, Ávila AOV. Comparação da distribuição de pressão plantar entre crianças normais e obesas. In: Anais do VII Congresso Brasileiro de Biomecânica; 1997; Campinas, Brazil.

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