

Therapeutic climbing: a possibility of intervention for children with cerebral palsy

Huayna Gabriel Barrios Koch¹, Gabriela de Oliveira Peixoto², Rita Helena Duarte Dias Labronici³, Natália Cristina de Oliveira Vargas e Silva⁴, Fabio Marcon Alfieri⁵, Leslie Andrews Portes⁶

ABSTRACT

Therapeutic climbing, an adaptation of sport climbing, can promote improvements in motor coordination, balance, and muscle endurance. **Objective:** The aim of this study was to evaluate the effects of this intervention on handgrip strength, postural control, functional mobility, and the spasticity control of children with cerebral palsy. **Method:** Case series study with 7 patients with a mean age of 9.6 ± 3.7 years, who took part in 1-hour sessions of therapeutic climbing twice a week. **Results:** After 19 sessions, there was an increase in handgrip strength of the right hand ($p = 0.022$) and improvement in static balance and gait ($p = 0.007$). Functional mobility also improved significantly ($p = 0.014$). The score on the Ashworth modified scale showed an efficient control of spasticity, although the difference has not reached statistical significance. **Conclusion:** Therapeutic climbing improved the handgrip strength, postural control, and functional mobility of patients.

Keywords: Child, Cerebral Palsy, Physical Therapy Modalities

¹ Physiotherapist, Policlínica do Centro Universitário Adventista de São Paulo - UNASP.

² Physiotherapist.

³ Researcher, Professor, Faculdade de Medicina do ABC - FMABC, Universidade Federal de São Carlos - UFSCar, Universidade Cidade de São Paulo - UNICID.

⁴ Professor, Professional Master in Health Promotion, Centro Universitário Adventista de São Paulo - UNASP.

⁵ Coordinator of the Master Course in Health Promotion, Centro Universitário Adventista de São Paulo - UNASP.

⁶ Professor, Professional Master in Health Promotion, Centro Universitário Adventista de São Paulo - UNASP.

Mailing address:

Centro Universitário Adventista de São Paulo - UNASP
Fabio Marcon Alfieri
Estrada de Itapecerica, 5859
São Paulo - SP
CEP 05858-000
E-mail: fabioalfieri@usp.br

Received on November 24, 2014.

Accepted on March 19, 2015.

DOI: 10.5935/0104-7795.20150008

INTRODUCTION

Cerebral palsy (CP) is a conglomeration of permanent disorders in motor and posture development that causes movement limitations that are attributed to a non-progressive disturbance in the fetal or infantile developing brain.¹ The CP motor disorders are frequently accompanied by sensory, perception, cognitive, behavioral, and communicative disorders, along with epilepsy and secondary musculoskeletal problems.¹

In developed countries, the estimated incidence of CP is of one child for every one thousand live births. However, in underdeveloped countries such as Brazil, the estimated incidence is much greater due to the precarious care given to pregnant women and their newborns.²

The variety of clinical descriptions under the CP umbrella is wide in terms of type, severity, body distribution of the primary motor limitation, of associated neurological and behavioral restrictions, as well as of functional deficits.³

Due to motor, gait, balance, and movement alterations, rehabilitation is necessary and very important to improve the performance of activities of daily living (ADLs), and thus overcoming limitations and providing autonomy.^{4,5} There are many schools of thought on the rehabilitation of children with CP for the upper limbs⁵ as well as for the lower limbs.⁴ Many resources can be used in this clinical condition such as stretching, strengthening, botulinum toxin, stationary bicycles, the use of orthoses, and constraint-induced movement therapy, among other things.^{4,5} Another probable resource to be used is therapeutic climbing.

Therapeutic climbing is an adaptation of the resources and movements used in sport climbing. This therapy was used for the first time in the 1980s in the United States to treat drug addicts, exploring their survival instinct and contributing to the management of their problem. In the 1980s and 90s, therapeutic climbing was introduced into the area of rehabilitation. In countries like Germany, Austria, and Switzerland, this therapy has been successfully used with children, adults, and the elderly for orthopedic and neurologic rehabilitation.⁶

Therapeutic climbing has also been used to increase the flexibility, stability, and strength of people with multiple sclerosis.⁷ This

activity can increase the strength of muscles in the trunk and improve muscle balance.⁸ One advantage of this type of therapy is that it is more interesting than some other types of exercise, which results in higher levels of adherence.⁹ Additionally, positive experiences with therapeutic climbing can increase confidence and self-efficacy, contributing to psychological well-being.⁹

Some authors have already evaluated the effects of therapeutic climbing on increasing gross motor coordination and reducing the spasticity of pediatric patients after traumatic brain injury or stroke.¹⁰ Also, it has been observed to improve balance, flexibility, quality of life, and self-esteem in individuals with multiple sclerosis.⁶ For patients with back pain, it was said to increase strength in the trunk muscles.¹¹ However, there is no evidence in the current literature on the effects of therapeutic climbing on patients with CP.

OBJECTIVE

This study sought to evaluate the influence of therapeutic climbing on handgrip strength, postural control, functional mobility, and spasticity control of children with cerebral palsy.

METHOD

This case series study was composed of eight patients with CP, with ages varying between 4 and 14 years, clinically presenting with hemiparesis. They were invited to participate in this study by the Department of Neurology of a University Polyclinic in the city of São Paulo. The study was approved by the Ethics Research Committee of the Centro Universitário Adventista de São Paulo (UNASP-SP), under protocol number 020/2009.

Patients with severe cognitive alterations and epilepsy were excluded from the study. The therapeutic one-hour sessions occurred twice a week, for three consecutive months. The patients were evaluated blindly by a physiotherapist at the beginning and end of the intervention, as described below.

The evaluation of peak handgrip strength was made with a dynamometer (Jamar, Lafayette Instruments, USA). The test was applied to the participant while sitting with the limb to be tested extended and without support, recording the best result of three attempts.¹²

The evaluation of postural control was made through the Guralnik battery of tests,¹³ that consisted of three items (static balance, gait speed, and the ability to get up from a chair), each ranked on a scale of 0 to 4 points, totaling 12 possible points, which meant that the greater the score, the better the performance of the individual for postural control. The static balance was evaluated in three different positions, from the simplest to the most complex. For gait speed, each patient was instructed to walk a distance of 4 meters at normal pace, using any support demanded normally. In order to test the ability to get up from a chair, the participant was asked to get up and sit down on a chair five consecutive times.

Functional mobility was evaluated with the Timed Up and Go test (TUG).¹⁴ This test consists of measuring the time (in seconds) needed for the patient to get up from a chair (without using their arms), walk a distance of 3 meters, turn around, and come back.

In order to evaluate spasticity, the modified Ashworth scale (mAS)¹⁵ was used to measure the resistance to the movement of a specific joint, through a scale that varies from 0 to 4 points.

All the patients in this study were submitted to the therapeutic climbing program on a climbing wall with fixed supports, which consisted of a track defined on the climbing wall up to a height that allowed safe jumping from the wall to the ground. Contrary to rock climbing, climbing with fixed supports is limited to a height of 3 meters, where the feet do not exceed 2 meters from the ground, due to safety equipment not being used.¹⁶ For the therapy, a wall 2.5 meters in height and 3.8 meters in width (9.5 m²) was used, with space for 200 supports. For this study, 77 fixed supports were used, all with large size for an easy grip, colored to provide good visual perception, and textured to reduce slippage.

The safety standards for climbing in schools¹⁶ were observed and, in addition, during the sessions, a physiotherapist remained close to the participant, helping him with the movements performed on the wall.

The one-hour sessions were developed based on the protocol proposed by Lazik et al.¹⁷ The first 10 minutes were for warm-up (respiratory and general stretching exercises). The first phase of training consisted of 20 minutes of wall climbing exercises (described below), followed by 10 minutes of relaxation

(recreational activities and games to reduce the cardiac and respiratory rates and to regulate muscle tone). After that, the patients entered a second phase of 10 minutes with the same exercises as in the first phase. The session ended with 10 minutes of relaxation. Within the limits and capacities of each participant, the exercises were done horizontally, diagonally, and vertically. The intervention included static exercises for a few seconds, exercises to reach the supports, climbing with maximum flexion of upper and lower limbs followed by maximum extension of the limbs, and circuits developed with the use of masking tape or even limiting the color of the supports to be used on the climbing path.

For the statistical analysis, the program GraphPad Prism 5.0 (www.graphpad.com) for Windows was used. The patients' data were compared through the Wilcoxon test, with significance level defined at 5%.

RESULTS

Out of the eight patients that began with the study, one was excluded from it for having missed two therapeutic climbing sessions. The mean age of the seven patients that completed the study was 9.6 ± 3.7 years. The anthropometric and gross motor coordination characteristics are shown in Table 1. As described in Table 1, three patients showed level I in the GMFCS E&R, three showed level II, and one participant showed level III.

After the therapeutic intervention, the patients showed improvement in the peak handgrip strength (Table 2). The therapeutic climbing led to a strength increase of 22.3% for the right hand ($p = 0.022$). Although there was an increase in the mean strength of the left hand (9.85 ± 6.36 kg in the initial evaluation and 10.64 ± 6.47 kg in the final evaluation), this result showed no statistical significance.

Regarding the postural control that evaluates the static balance, gait, and muscle strength, there was a significant increase in the score for the Guralnik battery of tests (Table 2). Before this study, the patients presented a mean score of 6.6 ± 3.2 that became 9.0 ± 3.3 after the intervention, which was an increase of 36.4% ($p = 0.035$). The TUG result (Table 2) shows that the patients improved their functional mobility, reducing the mean time to perform the agility test by 29.2% ($p = 0.016$).

As for spasticity (Table 2), the mAS results showed an improvement of 15.5%, although without statistical significance ($p = 0.149$).

Table 1. Anthropometric characteristics of children with cerebral palsy

GMFCS E&R of patients	Topography	Age (years)	Gender (F/M)	Height (m)	Weight (kg)	BMI (kg/m ²)
(II)	Hemiparesis (L)	7	F	1.21	35.0	23.9
(II)	Hemiparesis (R)	14	F	1.45	42.0	20.0
(I)	DIHM	12	M	1.41	31.6	15.9
(II)	Diparesis	13	F	1.55	45.4	18.9
(I)	Diparesis	7	M	1.19	19.0	13.4
(III)	Diparesis	10	M	1.42	34.4	17.1
(I)	Diparesis	4	M	1.08	16.8	14.4
Mean \pm SD		9.6 ± 3.7	3/4	1.33 ± 0.17	32.0 ± 10.8	17.7 ± 3.6

GMFCS E&R (levels I-IV): Gross Motor Function Classification System (GMFCS) Expanded & Revised; DIHM: diparetic involuntary hand movements; BMI: body mass index

Table 2. Functional aspects of children with cerebral palsy before and after the intervention with therapeutic climbing

	Before	After	Difference %	<i>p</i>
R handgrip (kg)	9.4 ± 6.2	11.5 ± 6.5	22.3	0.022
L handgrip (kg)	9.9 ± 6.4	10.6 ± 6.5	7.1	0.416
Guralnik Score	6.6 ± 3.2	9.0 ± 3.4	36.4	0.035
TUG(s)	13.05 ± 5.39	9.24 ± 2.58	29.2	0.016
mAS	2.714 ± 0.488	2.286 ± 0.488	-15.5	0.146

R/L handgrip: peak of right/left handgrip strength; Kg: kilogram; TUG: timed up&go; s: seconds; mAS: modified Ashworth Scale

DISCUSSION

The objective of this study was to evaluate the influence of therapeutic climbing as a therapeutic resource for children with cerebral palsy. The results have shown improvements in the handgrip strength, postural control, functional mobility, and spasticity control of these children.

In the present study, during the progression of sessions, an adaptive improvement of the movements was observed, which led to a better execution of the exercises in therapeutic climbing. Gaining strength is very important for these patients, for they probably start to perform activities of daily living (for example: holding a glass, opening a door, etc.) with more sureness and safety. As they gained handgrip strength, the participants became more independent on the climbing wall and progressively capable of executing more complex exercises.

Another important function for these patients that was also improved by the intervention was postural control. This improvement in the TUG test as well as in the Guralnik battery of tests results may have occurred due to the climbing wall demanding that the body adapt continuously to the changes in space that occurred during the exercise. In this way, the therapeutic climbing strongly stimulates these

patients to relearn movements, which breaches the compensatory behavior that can destabilize the patient on the climbing wall. The child starts, with the stimulation of postural correction while remaining on the support points of the climb, to have better balance control. This improvement in trunk control related to postural control may have facilitated the improvement in the execution of the upper limbs activities, since the trunk positioning can influence in the function of these limbs.⁵

Mobility, which is generally compromised in individuals with cerebral palsy,¹⁸ is extremely important for it allows the individuals to move around and position their bodies independently to perform the activities of daily living.¹⁹ Therefore, the improvement observed in this variable was something that had a positive impact on the lives of these patients.

Opportunities for rehabilitation with motivating activities are very important for the motor development of children with CP.²⁰ Consequently, climbing is an efficient way to change the patient's view of conventional therapy, since many standard exercises are made difficult by the patient's lack of cooperation. One example of that is the probable increase of strength in the lower limbs acquired through muscle training that has no adverse effect on muscle tone and is actually beneficial to the child.⁴ The activities that helped maintain the

postures that the climbing exercises demand, in addition to improving postural control and mobility, also provided a discreet improvement in their spasticity.

In relation to spasticity, our expectations were met with the reduction of rigidity in the patients. Before the treatment, the patients showed a higher mean score of spasticity (2.71 ± 0.49), bringing difficulties to passive movements. After therapeutic climbing, spasticity was reduced by 15.5%. This reduction, although not significant, supplemented the benefits to the patients, probably due to better muscle performance. These exercises may have increased the number of recruited motor units and improved the generation of force, thereby reducing rigidity and preserving the functional elasticity of the muscles.^{21,22} The only study mentioning reduction of spasticity in children submitted to therapeutic climbing offered no data, making it impossible to compare directly with the present study.

It should be reported, still, that the patients persistently adhered to the climbing therapy. They not only came assiduously to the therapeutic sessions, but also showed interest in each session.

The lack of scientific literature on therapeutic climbing and the small size of the present sample limited the results of the present study to a very specific group. Up until now, this has been the only study we know of that evaluated children with CP submitted to an intervention with therapeutic climbing. Nevertheless, despite the size of the sample, we believe the results were promising, for they reinforce the relevance of the present study and encourage new studies with the purpose of evaluating the effects of therapeutic climbing in this type of patient. Therefore, we believe randomized studies using conventional therapy and therapeutic climbing can provide greater support for the incorporation of this therapeutic resource in the treatment of children with CP.

CONCLUSION

Therapeutic climbing improved handgrip strength, postural control, and functional mobility of the patients. These results show that this therapeutic modality can be considered a promising intervention for children with CP.

REFERENCES

- 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.
- Pato TR, Pato TR, Souza DR, Leite HP. *Epidemiologia da paralisia cerebral.* Acta Fisiatr. 2002;9(2):71-6.
- Blair E. Epidemiology of the cerebral palsies. *Orthop Clin North Am.* 2010;41(4):441-55. DOI: <http://dx.doi.org/10.1016/j.jocl.2010.06.004>
- Capucho PY, Carnier SADC, Souza P, Castro DC, Finocchio AP, Oliveira DM, et al. Paralisia cerebral - membros inferiores: reabilitação. *Acta Fisiatr* 2012;19(2):114-22. DOI: <http://dx.doi.org/10.5935/0104-7795.20120018>
- Arakaki VC, Cardoso MCC, Thinen NC, Imamura M, Battistella, LR. Paralisia cerebral- membros superiores: reabilitação. *Acta Fisiatr* 2012; 19(2): 123-9. DOI: <http://dx.doi.org/10.5935/0104-7795.20120019>
- Kern C, Banik B, Bühlmeier K, et al. Multiple sclerosis and therapeutic climbing: an interventional long term pilot study indicates beneficial effects. In: Hoppeler H, Reilly T, Tzolakidis E, Gfeller L, Klossner S, editors. *Book of Abstracts. ECSS Lausanne 06: 11th annual Congress of the European College of Sports Science; 2006 Jul 5-8; Lausanne, Switzerland.* Available from: *European Database of Sport Science (EDSS).*
- Fleissner H, Sternat D, Seiwald S, Kapp G, Kauder B, Rauter R, et al. Therapeutic climbing improves independence, mobility and balance in geriatric patients. *Euro J Ger.* 2010;12(1):12-6.
- Heitkamp HC, Wörner C, Horstmann T. Sport climbing with adolescents: effect on spine stabilising muscle strength. *Sportverletz Sportschaden.* 2005;19(1):28-32. DOI: <http://dx.doi.org/10.1055/s-2005-857953>
- Buechter RB, Fechtelpeter D. Climbing for preventing and treating health problems: a systematic review of randomized controlled trials. *Ger Med Sci.* 2011;9:1-9.
- Nobile G, Meyer-Heim A, Niederberger P, Hahn S, Padden B, Knecht B. Therapeutic climbing in pediatric rehabilitation: a prospective pilot study with children after traumatic brain injury or stroke. *Swiss Med Wkly.* 2006; 136;(Supp151):22.
- Heitkamp HC, Mayer F, Böhm S. Effects of a climbing course on spine muscles in comparison to isokinetic strength training. *Akt Rheumatol* 1999;24:40-6. DOI: <http://dx.doi.org/10.1055/s-2008-1043545>
- Bellace JV, Healy D, Besser MP, Byron T, Hohman L. Validity of the Dexter Evaluation System's Jamar dynamometer attachment for assessment of hand grip strength in a normal population. *J Hand Ther.* 2000;13(1):46-51. DOI: [http://dx.doi.org/10.1016/S0894-1130\(00\)80052-6](http://dx.doi.org/10.1016/S0894-1130(00)80052-6)
- Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol.* 1994;49(2):M85-94. DOI: <http://dx.doi.org/10.1093/geronj/49.2.M85>
- Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc.* 1991;39(2):142-8. DOI: <http://dx.doi.org/10.1111/j.1532-5415.1991.tb01616.x>
- Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. *Phys Ther.* 1987;67(2):206-7.
- Winter S, Hinkel M. *Sicher nach oben. Klettern in der Schule.* Munich: Bundesverband der Unfallkassen (German Social Accident Insurance); 1999.
- Lazik D, Bernstädt W, Kittel R, Luther S. *Therapeutisches Klettern.* Stuttgart: Thieme; 2008.
- Kleiner AFR, Saraiva PM, Batistella RA, Pietrobon RS, Gobbi LTB. Mobilidade funcional em indivíduos com paralisia cerebral espástica de acordo com o tipo e a idade. *Rev Port Cien Desp.* 2008;8(3):406-13.
- Williams EN, Carroll SG, Reddihough DS, Phillips BA, Galea MP. Investigation of the timed 'up & go' test in children. *Dev Med Child Neurol.* 2005;47(8):518-24. DOI: <http://dx.doi.org/10.1017/S0012162205001027>
- Butterfield SA, Loois EM. Influence of age, sex, balance, and sport participation on development of throwing by children in grades K-8. *Percept Mot Skills.* 1993;76(2):459-64. DOI: <http://dx.doi.org/10.2466/pms.1993.76.2.459>
- Mayo NE, Korner-Bitensky NA, Becker R. Recovery time of independent function post-stroke. *Am J Phys Med Rehabil.* 1991;70(1):5-12. DOI: <http://dx.doi.org/10.1097/00002060-199102000-00003>
- Shepherd RB. Exercise and training to optimize functional motor performance in stroke: driving neural reorganization? *Neural Plast.* 2001;8(1-2):121-9. DOI: <http://dx.doi.org/10.1155/NP.2001.121>