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Effects of robotic intervention associated with conventional therapy on gait speed and resistance and trunk control in stroke patients

Efeitos da intervenção robótica associada à terapia convencional na velocidade e resistência de marcha e controle de tronco em pacientes após acidente vascular cerebral

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Abstract

Objective: To verify the effects of gait and robotic stair training with G-EO System, associated with conventional rehabilitation, on gait speed and endurance and trunk control of stroke participants. **Method**: Retrospective study with 28 participants in the chronic phase of the disease. G-EO System was used for gait and stair robotic intervention. 20-session protocol of 20 minutes associated with conventional multidisciplinary therapy. The 10-meter Walk Test (10mWT), 6-minute Walk Test (6MWT) and Trunk Impairment Scale (TIS) tools were used. P values <0.05 were considered statistically significant with Wilcoxon test before and after intervention. **Results:** Significant differences found in the tests. TIS presented initial mean value of 14.29 (± 5.30) and final value of 17.04 (± 4.49), with p = 0.00044. 10mWT presented average initial velocity of 0.498 m/s (± 0.27) and final velocity of 0.597 m/s (± 0.32), p = 0.00008. 6mWT presented mean initial value of 155.89m (± 85.96) and final value of 195.39m (± 109.78), p = 0.00152. **Conclusion**: Gait and stair robotic therapy, associated with conventional therapy, was effective in promoting increased speed, endurance aptitude for greater gait distances and trunk control in individuals with chronic stroke after stroke.

Keywords: Stroke, Gait, Recovery of Function, Neurological Rehabilitation, Robotics

RESUMO

Objetivo: Verificar os efeitos do treino de marcha e escada robótica, com o G-EO System, associado à reabilitação convencional, na velocidade e resistência de marcha e controle de tronco de participantes acometidos pelo acidente vascular cerebral (AVC). **Método:** Estudo

retrospectivo com 28 participantes na fase crônica da doença. Utilizou-se o G-EO System como intervenção de marcha e escada robótica. Protocolo de 20 sessões de 20 minutos associado à terapia multidisciplinar convencional. Utilizados as ferramentas de Teste de Caminhada de 10 metros(TC10m), Teste de Caminhada de 6 minutos(TC6min) e Escala de Deficiências de Tronco(EDT). Valores de p<0,05 foram considerados estatisticamente significativos com teste de Wilcoxon pré e pós intervenção. **Resultados:** Encontradas diferenças significativas nos testes. EDT apresentou valor médio inicial de 14.29 (±5.30) e final de 17.04 (±4.49), com p=0.00044. TC10m apresentou velocidade inicial média de 0.498 m/s (±0,27) e final de 0,597 m/s (±0.32), p=0.00008. TC6min apresentou valor inicial médio de 155.89m (±85,96) e final de 195.39m (±109.78), p=0.00152. **Conclusão:** Terapia de marcha e escada robótica, associada à terapia convencional, foi eficaz para promover aumento na velocidade, resistência e aptidão para maiores distâncias de marcha e controle de tronco nos indivíduos em fase crônica após acometimento de AVC.

Palavras-chave: Acidente Vascular Cerebral, Marcha, Recuperação de Função Fisiológica, Reabilitação Neurológica, Robótica

INTRODUCTION

Rehabilitating gait function is one of the main objectives for stroke patients, as it enables greater return to their activities and social participation.[1,2] Robotic gait training has been used to restore function in individuals after stroke, promoting motor relearning with repetitive, intensive and task-oriented training, with greater safety and less burden on therapists.[1,3,4]

The speed and endurance for longer walking distances of these individuals are important aspects that should be improved with rehabilitation.[5] In addition, proper trunk control is necessary for the individual to perform their functional activities with stability and safety.[6]

OBJECTIVE

The aim of the present study is to verify the effects of gait and stair robotic training, through the G-EO System, associated with conventional rehabilitation, on gait speed and resistance and trunk control of stroke patients. The findings may contribute to confirm the efficiency of the protocol used or improve it, as well as increase the clinical knowledge in the area and help the clinical practice of professionals working with robotics.

METHODS

This is a retrospective observational study, through analysis of medical records data, approved by the ethics and research committee with opinion number CAAE: 96949118.0.0000.0068. The study was carried out at the Institute of Physical Medicine and Rehabilitation, Hospital das Clínicas, School of Medicine, University of São Paulo - Brazil (IMREA-HCFMUSP).

Initially, 137 medical records were selected for analysis, including all participants who had at least one session in the equipment. Of these, 57 were initially excluded, 11 because they participated in a research project involving the use of transcranial magnetic stimulation in the period, 34 because they performed less than twenty sessions, 1 because they were undergoing metastatic cancer treatment, 5 because they did not perform a final assessment after the training protocol, 3 due to behavioral disorder that could influence the response to the tests, 2 due to the lack of initial protocol assessment, 1 due to knee orthopedic problem. Thus, there were 80

other records of participants who completed the 20 robotic training sessions, of which, later, 52 were excluded because they did not perform the pre or post intervention assessments of the scales chosen for the present study.

Therefore, the analysis of results of a final sample was made with records of 28 participants in the chronic phase of stroke who underwent robotic training between July 2013 to December 2018, the sample had a mean age of 49.03 years (± 15.66) , being 14 men and 14 women.

G-EO System (Reha Technology, Olten, Switzerland) was used for therapeutic intervention in robotic gait. It consists of a bodyweight suspender and two robotic platforms that enable gait and stair training. The protocol performed was composed of 20 sessions of 20 minutes each, two times a week and may include gait, climb and down stairs modality.

As a retrospective study, the time of each modality was not controlled and identical to all, being at the discretion of the physiotherapist who attended the participants each modality time, as needed by the patient. Suspension of body weight was not used in any of the participants, being the support of the same used only as a safety vest. In addition, during this period, participants also underwent conventional therapy, consisting of a multiprofessional program.

Conventional physiotherapy occurred twice a week, with 50-minute care, consisting of stretching, strengthening, mobilization and functional training exercises (use of functional electrical stimulation, active lower-limb cycle ergometer, standing, balance, gait training and body awareness exercises), also including safety and independence training for activities of daily living.

For analysis of pre and post effects of robotic gait training associated with conventional therapy, it was used the 10-meter Walk Test (10mWT)[7] which assesses gait speed, the 6-minute Walk Test (6MWT),[8] which assesses gait resistance, that is, how many meters the individual walks in 6 minutes, and the Trunk Impairment Scale (TIS)[9] which assesses the degree of involvement of this segment and its level of selective control.

Data collection was performed by researchers who did not have access to their application when participants underwent the rehabilitation program. Data analysis was performed using the SigmaStat program. The normality of the distribution of variables was tested by the Kolgomorov-Smirnov method. As there was a non-normal distribution of variables, to compare pre and post intervention effects, the Wilcoxon test was used. P values <0.05 were considered statistically significant.

RESULTS

Of the 28 participants, an average of 24.92 ± 12.18 months was found between the stroke episode and the start of robotic therapy. Of these, 16 had mild disability (unable to perform all previous activities but independent for personal care), 10 moderate disability (require some help but able to walk without assistance) and 2 moderately severe disability (unable to walk without assistance and unable to perform their own physiological needs without assistance), according to the Rankin scale.[10]

Table 1 shows the results before and after 20 robotic intervention sessions associated with conventional therapy.

Table 1. Comparison of pre and post intervention results

Variable		Sample with n = 28 mean ± standard deviation	post-pre, p value
10mWT (m/s)	before	0.498±0,27	0,099; p=0.00008*
	after	0.597±0,32	
6MWT (m)	before	155.89±85.96	39,5; p=0.00152*
	after	195.39±109.78	
TIS	before	14.29±5.30	2,75; p=0.00044*
	after	17.04±4,49	

*n-number of participants; 10mWT-meter Walk Test; m/s- meters per second; 6MWT- 6-minute Walk Test; m-meters; TIS-Trunk Impairment Scale;*Wilcoxon with significance of p <0.05*

Participants showed significant differences in the tests performed. The 10mWT presented an average initial velocity of 0.498 m/s (±0.27) and final velocity of 0.597 m/s (± 0.32), with p = 0.00008. The 6MWT presented a mean initial value of 155.89m (±85.96) and final value of 195.39m (±109.78), with p = 0.00152. TIS presented an average initial value of 14.29 (± 5.30) and final of 17.04 (± 4.49), with p value = 0.00044.

DISCUSSION

The association of conventional therapy with robotic training enabled greater gait speed and endurance and trunk control in individuals with chronic stroke.

The stair climbing exercise is a way to strengthen the lower limbs and also the trunk muscles, and a strengthening of the trunk muscles is essential for its stabilization and greater control of this segment.[11] In turn, good trunk control is essential for stroke patients to regain their mobility and independence, besides being a predictor for recovery of walking ability.[12]

In addition, G-EO System is an end-effector robot that modulates the individual's gait by coupling their feet on distal platforms. This kind of equipment leaves the user's body freer than exoskeleton robots, generating greater trunk oscillations, requiring greater activation of the region and performing greater trunk control during robotic therapy.[3] These factors may have contributed to an improvement in the results obtained by TIS, presented in the results.

After stroke, individuals move with lower speed and resistance, impairing their social participation.[13] Thus, these are important markers for the rehabilitation of stroke patients, since the goal of treatment is that they are able to achieve safe locomotion with a functional speed, as far as possible for each case. The association of conventional therapy with robotic training was effective to improve these aspects in the sample.

The robotic device generates a precise gait cycle with intense repetition of it, thus assisting in motor relearning of this pattern, promoting a neuroplasticity of the pathways and functional improvement of this ability.[14]

In addition to gait training, G-EO System brings as an innovation stair climbing and descent training, performed in a safer way than in conventional physiotherapy. Stair training can, in turn, increase muscle strength, coordination, balance and cardiorespiratory conditioning.[12] Thus, with the improvement of these aspects, it is also possible to improve the resistance for walking at greater distances, which may have contributed to an increase in the 6MWT.

This was the first study conducted in South America using G-EO System to rehabilitate the stroke population. The study has several limitations, such as not controlling the specific protocol of robotic therapy. For performing a retrospective analysis of an equipment used in the institution's routine care, there was no control of the speed used, time of each gait and stairs modality, and progression during the 20 sessions. There was also no control group, which makes it impossible to describe and separate motor gains due to robotic therapy and conventional therapy. Ideally, studies with group separation between therapies should be performed. This study group is in the process of conducting new research with advances in these aspects.

CONCLUSION

Robotic gait and up and down stairs training, associated with conventional therapy, was effective to promote increase in gait speed, trunk control, endurance and fitness for greater walking distances in individuals in the chronic phase after stroke, with respective significant increases in the scores of the 10-meter walk test, 6-minute walk test and TIS. Thus, the robotic intervention can be considered a good resource to be implemented in the rehabilitation program, allowing users a higher quality of life and functionality.

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