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ORIGINAL RESEARCH

Eight-point binding as a physical therapeutic resource for rehabilitation of functional performance after a stroke

Enfaixamento em oito como recurso fisioterapêutico para reabilitação do desempenho funcional após acidente vascular encefálico

Vendaje en ocho como recurso fisioterápico para rehabilitación del desempeño funcional tras accidente cerebrovascular

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ABSTRACT | A stroke may leave neurological, motor and sensory sequelae, interfering with the function of movements and culminating in gait and balance changes. Therefore, it is necessary to demonstrate the efficacy of eight-point binding, a low-cost technique that functions to provide proprioceptive information and promote the biomechanical alignment of the ankle, acting against mechanisms that lead to equinovarus foot. This study aims to determine the immediate effect of eight-point binding as a physical therapy resource for the rehabilitation of function performance after a stroke. To this end, 22 patients who were able to walk alone without an orthosis were evaluated, and performed the Timed Up and Go (TUG) functional mobility test, a gait speed assessment and the Berg Balance Scale, with and without the eight-point binding in the paretic lower limb. When comparing the results after the eight-point binding, it was possible to observe a statistically significant difference (p<0.05) in all of the studied variables. After analyzing the results, it was concluded that after a single application of eight-point binding, it is possible to identify statistically significant improvement in gait speed, functional mobility and balance after a stroke.

Keywords | Stroke/complications; Gait; Postural Balance; Orthotic Devices.

RESUMO | O Acidente Vascular Encefálico (AVE) pode deixar sequelas neurológicas, motoras e sensitivas, interferindo na função dos movimentos e culminando em alterações na marcha e no equilíbrio. Sendo assim, há a necessidade de se comprovar cientificamente a eficácia do enfaixamento em oito, uma técnica de baixo custo que tem como função fornecer informações proprioceptivas e promover o alinhamento biomecânico do tornozelo, agindo contra os mecanismos que levam ao pé equinovaro. O objetivo deste estudo foi determinar o efeito imediato do enfaixamento em oito como recurso fisioterapêutico para a reabilitação do desempenho funcional após AVE. Para tanto, participaram deste estudo 22 pacientes que foram capazes de deambular sozinhos, sem auxílio de órteses, que realizaram o teste de mobilidade funcional *Timed Up and Go* (TUG), a avaliação da velocidade da marcha e da escala de Equilíbrio de Berg, com e sem o enfaixamento em oito no tornozelo do membro inferior parético. Quando comparados os resultados antes e após o enfaixamento em oito, foi evidenciada diferença estatisticamente significante (p<0,05) em todas as variáveis avaliadas. Após análise dos resultados, foi possível concluir que após uma única aplicação do enfaixamento em oito, é possível identificar melhora estatisticamente significante na velocidade da marcha, mobilidade funcional e equilíbrio de hemiparéticos crônicos pós-AVE.

Descritores | Acidente Vascular Cerebral/complicações; Marcha; Equilíbrio Postural; Aparelhos Ortopédicos.

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RESUMEN | El accidente cerebrovascular (ACV) puede dejar secuelas neurológicas, motoras y sensoriales, interfiriendo en la función de los movimientos y culminando en cambios en la marcha y el equilibrio. Por ende, hay la necesidad de comprobarse científicamente la eficacia de vendaje en ocho, una técnica de bajo costo que tiene la función de proporcionar informaciones propioceptivas y promover la alineación biomecánica del tobillo, actuando en contra de los mecanismos que conducen al pie equinovaro. El objetivo de este estudio fue determinar el efecto inmediato de los vendajes en ocho como recurso fisioterápico para la rehabilitación del desempeño funcional tras accidente cerebrovascular. Para ello, participaron de este estudio 22 pacientes los cuales fueron capaces de caminar solos, sin la ayuda de aparatos ortopédicos, y que realizaron el test de la movilidad funcional *Timed Up and Go* (TUG), la evaluación de la velocidad de la marcha y de la escala de Equilibrio de Berg, con y sin el vendaje en ocho del tobillo de la extremidad inferior parética. Al comparar los resultados antes y después de los vendajes, fue evidenciada diferencia estadísticamente significativa (p<0,05) en todas las variables evaluadas. Después de analizar los resultados, se concluyó que, después de una sola aplicación de vendajes en ocho, es posible identificar una mejoría estadísticamente significativa en la velocidad de la marcha, la movilidad funcional y el equilibrio de hemiparéticos crónicos tras accidente cerebrovascular.

Palabras clave | Accidente Cerebrovascular/complicaciones; Marcha; Equilíbrio Postural; Aparatos Ortopedicos.

INTRODUCTION

There are several sequelae that can be caused by stroke, including sensitive, cognitive and motor changes, such as muscle weakness, spasticity, abnormal movement patterns and physical decontitioning[1]. Besides, after brain lesion, the ability to walk can be substantially changed, and it is often possible to observe changes in speed, cadence, symmetry and increasing energetic output during gait[2,3]. It is important to mention that 8 to 14% of the hemiparetic individuals need help walking, and 22 to 37% need wheel chairs[4].

The lack of skills to produce and regulate voluntary movement, the inadequate activation of muscles and the decreased ankle joint mobility on the affected side cause changes in gait, and it also compromises the support of the calcaneus in the first contact. This leads to increased lateral plantar support and reduced impulse phase[2]. Besides, in balance, there is the need for excessive hip flexion so that the foot is not dragged on the ground[2,5]. These changes lead to decreased step length and reduced gait speed.

Body asymmetry and difficulties to support the weight on the affected side are consequences of these changes, which interfere in the ability to maintain postural control and stability to perform movements with trunk and limbs[6,7]. This can lead to higher risks of falls[8], which compromises functional independence and quality of life of post-stroke hemiparetic patients.

Therefore, several resources are proposed to assist gait and balance rehabilitation, such as the use of ankle and foot orthosis, which would help ankle alignment and improve balance, thus decreasing energetic output. However, these are expensive and not accessible in developing countries, therefore, it is necessary to dispose of other options of orthosis, at lower costs, however, with the same purpose of the traditional orthosis.

For that end, it is possible to mention the eight-point binding, a low cost technique (since it can be performed with a semi-elastic crepe bandage[2,9]) that aims at providing proprioceptive information and promoting biomechanical ankle alignment, which allows foot tensioning for dorsiflexion and foot eversion. It works against the mechanisms that lead to equinovarus foot and favors the oscillation of the hemiparetic lower limb during gait[9].

Despite the satisfactory results found in previous studies[2,9], there are not enough scientific subsidies to prove the beneficial effect of binding as a physical therapy resource. Up until now there are only two published studies[2,9]; however they were conducted with a limited number of patients and with a heterogeneous sample.

Therefore, it is necessary to give scientific credibility to the use of binding as a physical therapy resource, by analyzing its effect in a homogeneous sample and with the adequate number of patients, determined by sample calculation. The objective of this study was to analyze the immediate effect of eight-point binding as a physical therapy resource for the rehabilitation of post-stroke functional performance. This study aims at providing relevant data for the elaboration of proper treatment plans to improve post-stroke functional performance.

METHODOLOGY

Participants

Chronic hemiparetic patients due to stroke were recruited and assisted by the outpatient clinic connected to the Physical Therapy Department of *Universidade Nove de Julho*. Inclusion criteria were: being clinically diagnosed with ischemic or hemorrhagic stroke for more than six months, primary or recurrent; being 20 years old or more; presenting with weakness and/or spasticity of the affected side; strolling without the auxiliary device; presenting total ankle joint mobility, assessed according to the Joint Mobility Test of hands and feet[10], with up to level II of hypertonia in triceps surae, according to the modified Ashworth scale[11]. Exclusion criteria were: individuals presenting pain during gait; conditions, except for stroke, that affect normal gait, such as muscle injuries, fractures in lower limbs or balance disorders, or also some compromise associated with hemiparesis that would contraindicate the use of eight-point binding, such as vascular disorder or skin conditions. Besides, individuals with cognitive impairment, screened by the Mini Mental State Examination (MMSE)[12] were also excluded from the study.

All of the participants signed the informed consent form and were informed about the possibility of abandoning the study at any phase, without punishment. This study was analyzed and approved by the Research Ethics Committee of *Universidade Nove de Julho* (protocol n. 410939/11).

Measurement instruments for evaluation

Natural and maximum gait speeds (GS)[13] were assessed by an important functional performance measure, with proper reliability among hemiparetic patients[14]. The protocol proposed by Flansbjer *et al.*[14] was used, and GS was calculated (m/s) in 10 meters, considering the mean of three repetitions for each speed[14].

The Timed Up and Go (TUG) test was used to indicate functional mobility. It presents adequate psychometric properties in individuals with history of stroke, and it comprehends important daily activities, which present high risk of falls[15]. The test consists of standing up from a chair with armrest pads, walking 3m, turning 180º and returning to the chair. In order to apply TUG, the protocol proposed by Podsiadlo *et al.*[15] was adopted, and the mean time of three repetitions was used with a digital chronometer[16]. When time is equal to or higher than 14 seconds in TUG, it indicates higher risks of falls[15,17].

Functional balance measures were obtained by applying the Brazilian version of the BERG balance scale[17]. This scale allows the quantitative assessment of the performance of the individual during functional tasks, such as reaching and transferring. The scale assesses balance based on 14 common daily items. Each item of the scale presents a response alternative in ordinal scale, ranging from 0 to 4 points. The maximum possible score is 56, and the cutoff point for risk of falls is 45.

Procedures

Initially, the possible volunteers were screened according to inclusion and exclusion criteria. Afterwards, demographic data of the eligible volunteers were collected, and, immediately after, subjects were submitted to evaluation with the application of the Timed Up and Go test (TUG)[16] for the assessment of functional mobility, natural and maximum gait speed15 and the BERG Balance scale[17], with bare feet and the eight-point binding in the hemiparetic ankle. The order of assessment was random, chosen by raffle in a sealed and opaque envelope.

The evaluations were conducted by the same evaluator, and the eight-point binding was made with high compression elastic bandage, from FAMARA. It was also performed by the same examiner, being placed in the hemiparetic ankle (Figure 1).

Statistical analysis

The sample size was determined after the performance of a pilot study with the first five assessed individuals. By adopting the standard deviation of the natural gait speed (0.15m/s), the necessary sample for 80% power was calculated (α=0.05, β=0.20). Therefore, sample size was estimated in 10 individuals, and 30% of possible losses was added during the study. The final n was obtained from at least 13 individuals.

Descriptive statistics was used for sample characterization, by means of central tendency (mean) and dispersion (standard-deviation) for quantitative variables and frequency for categorical variables. Non-parametric variables were summarized in median and interquartile

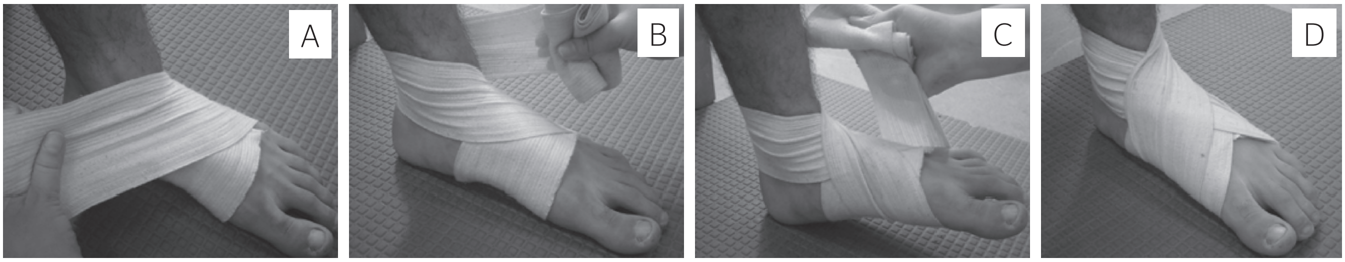

Figure 1. (A) beginning of the eight-point binding in the plantar arch. (B) Beginning the eight-point binding behind the ankle. (C) Sequence of eight-point binding by positioning the ankle joint in eversion and plantar dorsiflexion. (D) Concluded eight-point binding

interval (25 and 75%). For the comparison of clinical and demographic data of the volunteers in the study, the non-paired Student's t-test was used.

The Shapiro-Wilk normality test was used to verify the normality of data, which resulted in the use of Wilcoxon to compare the BERG balance scale before and after the use of eight-point binding in the ankle of the paretic lower limb. As to natural and maximum gait speed and the functional Time Up and Go test (TUG) the paired Student's *t*-test was used.

In all of the inferential analyses, the α=0.05 significance level was considered.

RESULTS

Among the 35 screened hemiparetic patients seven were excluded from the study for presenting with osteomuscular diseases associated with stroke, and six other patients presented with cognitive impairment. Therefore, the eligible population was composed of 22 hemiparetic volunteers due to stroke, who met the established inclusion criteria, being 11 women and 11 men. Their clinical and demographic characteristics are shown in Table 1, in which it is possible to observe there was no statistically significant difference related to age, time of injury and functional performance (natural and maximum gait speed, mobility and functional balance), thus characterizing a homogeneous sample.

About the comparison between gait speed (natural and maximum), functional mobility (TUG) and balance (BERG), before and after the eight-point binding, it is possible to observe, in Table 2, there has been statistically significant improvement in all of the variables with the use of binding in the hemiparetic ankle.

Table 1. Clinical and demographic characteristics of the volunteers in the study

Subjects (n=22)	Women (n=11) Mean±SD	Men (n=11) Mean±SD	p-value
Age (years)	59.63±12.01	59.63±12.01	0.58
Time of stroke (months)	51.54±63.23	54.81±70.40	0.59
Natural GS (m/s)	0.63±0.27	0.61±0.35	0.10
Maximum GS (m/s)	0.89±0.45	0.85±0.38	0.18
Functional mobility (TUG) (s)	21.15±8.43	21.08±9.02	0.16
Balance (BERG)	50 (44/53)	50 (42/54)	0.13

GS: Gait speed; TUG: Timed Up and Go; BERG: Berg Balance Scale. Statistical analysis performed with the non-paired Student's t-test. SD: standard deviation; Med: Median; IQ: interquartile interval

Table 2. Comparison of functional performance variables (natural and maximum gait speed, TUG and BERG), before and after the eight-point binding.

	Without binding Mean±SD	With binding Mean±SD	p-value
Natural GS (m/s)	0.64±0.27	0.70±0.30	0.001
Maximum GS (m/s)	0.87±0.45	0.92±0.39	0.001
Functional mobility (TUG) (s)	20.18±8.43	18.32±7.66	0.001
Balance (BERG) - Med (IQ25-75%)	50 (44/53)	51 (46/53)	0.007

GS: gait speed; TUG: timed up and go; BERG: Berg balance scale. Statistical analysis performed with the paired Student's t-test. SD: standard deviation; Med: Median; IQ: interquartile interval

DISCUSSION

The purpose of this study was to determine the immediate effect of eight-point binding as a physical therapy resource for the rehabilitation of post-stroke functional performance, assessed by gait speed, functional mobility and dynamic balance, in order to contribute with the clinical treatment and the rehabilitation of hemiparetic individuals. After the analysis of the obtained results, it was possible to observe statistically significant difference in all of the variables.

Natural and maximum gait speeds were used as one of the outcomes to characterize the functional level of post-stroke hemiparetic patients, since gait is an essential measure to assess human gait1[8]. After evaluation, it was possible to observe there was statistically significant difference in the assessment of natural and maximum gait speed after the use of binding in all of the assessed patients.

Such finding corroborates the study by Torriane *et al.*[2], which compared the number of steps, cadence and gait speed in post-stroke hemiparetic patients, with and without the use of the resource. The study concluded that eight-point binding was favorable for the improved functionality, increased speed and gait quality. However, it is important to mention that the study by Torriane *et al.*[2] assessed only 12 patients, and the method used to analyze the studied variables was different from the methods used in this study.

In another study by Torriane *et al.*[9], eight-point binding was also efficient among hemiparetic individuals by different etiologies, resulting from upper and lower motor neuron conditions, besides neurodegenerative diseases. In spite of the heterogeneity of the sample and the limited number of assessed individuals, it was possible to observe that the eight-point binding promoted increased gait in patients with dorsiflexion difficulties.

Even though gait speed is mainly affected by the weakness of hip flexors and knee extensors, temporal and spatial asymmetry is firstly influenced by the level of hypertonia of plantar flexors and by the difficulty to perform ankle dorsiflexion[2].

Facing that, it is possible to infer that the effect of the eight-point binding occurs because it works to replace the ankle and to increase dorsiflexion, thus promoting the improvement in calcaneus support at the initial contact, and improved oscillation of the paretic limb in the balance stage. Besides, since it is a flexible resource, the eight-point binding allows plantar flexion during the pre-balance phase, therefore facilitating the impulsion of the lower limb and contributing with the increased gait speed.

By considering the mean time of TUG, it was possible to observe a statistically significant difference after the use of the eight-point binding. However, the assessed volunteers were classified with mobility problems[15], and with higher risk of falls[19], since when time in TUG is equal to or higher than 14 seconds, it indicates more risk of falls[16], and the study volunteers took in average 20 seconds to perform the test without binding, and 18 seconds with binding. However, from the clinical point of view, this decreasing time to perform the test can represent advances in the treatment of functional mobility.

Concerning the functional balance assessed by the BERG scale, a statistically significant difference was also observed. After the use of binding, patients obtained median of 50 points in the balance evaluation with the BERG scale, which is equivalent to only 6 to 8% of chances of falls[20]. This demonstrates that the eight-point binding improves balance and postural control of hemiparetic patients. This finding is similar to the results reported by Torriane *et al.*[2], which, at assessing post-stroke hemiparetic patients, before and after binding, also observed improved balance after the use of the resource. However, the instrument to assess balance was different from the one used in this study.

The formulated hypothesis is that the results obtained in this study are due to the replacement of the ankle joint, which, with the use of the eight-point binding, favors the approximation of the origin and muscle insertion of the tibialis anterior, thus increasing its ability to generate contraction and increasing gait speed and stability in patients with hemiparesis.

However, it is important to mention that the limitation of this study refers to the fact of analyzing only the immediate effect of eight-point binding. Therefore, we point out the need to perform longitudinal clinical studies, so it is possible to determine cause and effect relationships between the studied variables, since cross-sectional studies, such as the one performed here, do not provide causality relations. We also emphasize the lack of studies about the eight-point binding effect in post-stroke rehabilitation, which limited the comparison of the obtained results with findings in literature.

Despite the mentioned limitation, the results obtained here are extremely relevant for the physical therapy and rehabilitation field, since it scientifically proves the efficacy of a new additional resource to conventional physical therapy, which promotes statistically significant improvement in the functional performance of individuals with chronic hemiparesis due to stroke. We state that this study is the only one, until now, that assessed the effect of the eight-point binding in a homogeneous sample with adequate sample size, determined by sample calculation. Therefore, it is necessary to mention that this resource is auxiliary to conventional physical therapy, and does not aim at replacing orthosis or any other device used by the patients.

CONCLUSION

To sum up, it is possible to state that the eight-point binding proved to be an efficient physical therapy resource for the rehabilitation of post-stroke functional performance, because after a single application of the eight-point binding, it was possible to identify statistically significant improvement in gait speed, functional mobility and balance of individuals with chronic hemiparesis due to stroke.

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