

Effect of eight-point binding in static balance and distribution of plantar pressure after stroke

Efeito do enfaixamento em oito no equilíbrio estático e distribuição de pressão plantar após acidente vascular encefálico

Efecto del vendaje en ocho para el equilibrio estático y la distribución de la presión plantar pos-acidente cerebrovascular

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ABSTRACT | The equinovarus foot is a common sequela after a cerebrovascular accident (CVA), the biomechanical changes of hemiparetic ankle interfere in balance and body asymmetry after a stroke. Several resources are used to minimize these changes, among them stands out the eight-point binding, which aims to provide proprioceptive information and promote the biomechanical alignment of the ankle, thus acting against the mechanisms leading to equinovarus foot. However, there is still no evidence of the effect of eight-point binding in static balance and plantar pressure distribution of the hemiparetic ankle. Thus, the aim of this study was to evaluate the immediate effect of eight-point binding on static balance and plantar pressure distribution in patients with hemiparesis due to stroke. To this end, we evaluated 30 subjects with chronic hemiparesis who were evaluated at three different times: without bandaging, with bandaging, and after five minutes of use of bandaging. The subjects were positioned on a force platform to assess balance and plantar pressure. For data analysis we used ANOVA for repeated measures, assuming $\alpha \leq 0.05$ risk. There was no statistically significant difference in static balance and plantar pressure distribution after the use of eight-point binding in any of the evaluated moments in this study. It follows that a single application of the eight-point binding is not able to generate clinical changes in static balance and plantar distribution. It is suggested that further studies need to be conducted to examine the effect of prolonged use of eight-point binding.

Keywords | Stroke; Orthotic Devices; Paresis; Postural Balance.

RESUMO | O pé equinovaro é uma sequela comum após o Acidente Vascular Encefálico (AVE), as alterações biomecânicas do tornozelo hemiparético interferem no equilíbrio e na assimetria corporal após o AVE. Diversos recursos são utilizados para minimizar essas alterações, entre estas, destaca-se o enfaixamento em oito, que visa fornecer informações proprioceptivas e promover o alinhamento biomecânico do tornozelo, agindo assim contra os mecanismos que levam ao pé equinovaro. Entretanto, ainda não há evidências do efeito do enfaixamento em oito no equilíbrio estático e na distribuição da pressão plantar do tornozelo hemiparético. Diante disso, o objetivo deste estudo foi avaliar o efeito imediato do enfaixamento em oito no equilíbrio estático e distribuição de pressão plantar de indivíduos com hemiparesia em decorrência do AVE. Para tanto, avaliou-se 30 indivíduos com hemiparesia crônica que foram avaliados em três momentos distintos: sem enfaixamento, com enfaixamento e após cinco minutos de uso do enfaixamento. Os indivíduos foram posicionados sobre uma plataforma de força para avaliação do equilíbrio e pressão plantar. Para análise dos dados utilizou-se o teste ANOVA para medidas repetidas, assumindo risco $\alpha \leq 0,05$. Não foi evidenciada diferença estatisticamente significativa no equilíbrio estático e na distribuição da pressão plantar após o uso do enfaixamento em oito em nenhum dos momentos avaliados neste estudo. Conclui-se que uma única aplicação do enfaixamento em oito não é capaz de gerar mudanças clínicas no equilíbrio estático e na distribuição plantar. Sugere-se que outros estudos

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sejam realizados para analisar o efeito do uso prolongado do enfaixamento em oito.

Descritores | Acidente Vascular Cerebral; Aparelhos Ortopédicos; Paresia; Equilíbrio Postural.

RESUMEN | El pie equinovaro es una secuela pos-accidente cerebrovascular (ACV), las alteraciones biomecánicas del tobillo hemiparético interfieren el equilibrio y la asimetría corporal pos-ACV. Se utilizan diversos recursos para minimizarlas, en los cuales se destaca el vendaje en ocho, que tiene el propósito de fornecer informaciones propioceptivas y de promocionar el alineamiento biomecánico del tobillo, actuando en contra de mecanismos que dejan el pie equinovaro. Sin embargo, no hay evidencias todavía del efecto del vendaje en ocho para el equilibrio y la distribución de la presión plantar del tobillo hemiparético. Teniendo en cuenta eso, este estudio tuvo el objetivo de evaluar el efecto inmediato del vendaje en ocho para el equilibrio estático y la

distribución de la presión plantar de sujetos con hemiparesia debido al ACV. Para ello, se evaluaron 30 sujetos hemiparéticos crónicos en tres momentos distintos: sin vendaje, con vendaje y tras cinco minutos utilizando el vendaje. Los participantes fueron puestos en una plataforma de fuerza para evaluar el equilibrio y la presión plantar. Para análisis de datos se utilizó el test ANOVA para medidas repetidas, asumiendo el riesgo de $\alpha \leq 0,05$. No hubo diferencias estadísticamente significativas en el equilibrio estático y en la distribución de la presión plantar tras el uso del vendaje en ocho en ningún de los momentos evaluados en este estudio. Se concluye que una sola aplicación del vendaje en ocho no es suficiente para producir cambios clínicos en el equilibrio estático y en la distribución plantar. Se recomienda que sean realizadas otras investigaciones para evaluar el efecto a largo plazo del vendaje en ocho.

Palabras clave | Accidente Cerebrovascular; Aparatos Ortopédicos; Paresia; Balance Postural.

INTRODUCTION

Cerebrovascular Accident (CVA) is characterized as the most common type of brain disorder, caused by the formation of a blood clot responsible for blocking the blood flow that reaches the brain tissue, or by the disruption of the blood vessel, thus causing brain hemorrhage and impairing the brain tissue¹. As a consequence to this poor oxygenation of nerve cells, problems may occur in the motor, sensory, and mental functions, in addition to language and perception impairment². The most evident impairment in the motor area in CVA is hemiparesis, which causes loss of motor control on one side of the body³.

As a consequence of these changes, body asymmetry and difficulty in supporting the weight on the affected side occurs, interfering in the ability to maintain postural control, causing greater risks of falls⁴. These changes cause disturbances on static and dynamic balance, and therefore interfere with the return of functional activities⁵. Thus, ankle/foot orthosis can be a suitable option for a good positioning of the joint⁶. However, these orthoses have high cost, making necessary the use of other orthotic options of lower cost that have the same purpose of the traditional orthosis.

Hence, alternative and less expensive resources have been used such as bandaging in eight in the paretic ankle^{7,8}. This resource aims at providing proprioceptive information and promoting the biomechanical

alignment of the ankle, allowing foot tension to eversion and dorsiflexion^{7,8}. This technique is of easy use and low cost, commonly used in clinical practice, and it had already showed scientific evidence as an auxiliary resource to conventional physiotherapy in the recovery of functional performance after CVA⁸.

Despite satisfactory results in previous studies^{7,8}, there is no sufficient scientific knowledge to prove the beneficial effect of bandaging on static balance recovery yet. So far, there are few published studies^{7,8}, and none of them analyzed the effect of bandaging on static balance and plantar pressure distribution. The hypothesis formulated is that the repositioning of the ankle joint using bandaging in eight favors the approximation of the muscular origin and insertion of the anterior tibialis, increasing its capacity to generate contraction and stability in individuals with hemiparesis. In addition, the proprioceptive stimulation could favor the improvement of plantar distribution.

Therefore, the objective of this study was to analyze the immediate effect of bandaging in eight on static balance and plantar pressure distribution in patients who have had CVA to verify the distribution of loads under the plantar surface without, with, and after five minutes of use of bandaging in eight in the ankle/foot, and the oscillations of the points of strength in relation to the speed and to the anterior-posterior and latero-lateral displacement. Thus, this study aims to assist rehabilitation courses and to favor the targeting of more appropriate treatment strategies.

METHODOLOGY

Participants

After the approval of the Research and Ethics Committee of Nove de Julho University (Protocol no. 334248/2012), we performed the triage of adult individuals suffering from chronic hemiparesis due to CVA at the Neurology Clinic of Nove de Julho University, according to the following criteria: to be an adult suffering from hemiparesis due to ischemic or hemorrhagic CVA; to present cognitive capacity to understand the informed consent form and follow instructions to perform the tests; and to present passive articular mobility of the ankle according to the Joint Mobility Test for Hands and Feet and the Modified Ashworth Scale¹⁰. The individuals could not present vascular or cutaneous disorders at the site of the bandaging; could not present other neurological or orthopaedical changes, in addition to other pathologies that led to the balance disorder; do not have pain during the upright position or gait; and do not present muscle injuries at the inferior members, fractures, or decrease in the passive Range of Motion (ROM) of the ankle.

We required a formal authorization from the individuals included, in which they compromised themselves to follow the rules of the research, based on the proposals of the Research Ethics Committee. Then, the following evaluations were carried out:

Evaluation tools

For the evaluation of the static balance and plantar pressure distribution, we used the force platform from the TekScan brand, MatScan model (0.50x0.60 cm), in which the oscillations of the points of strength regarding speed and antero-posterior (AP) and mean-lateral (ML) displacement were analyzed, enabling the evaluation of the balance by

Center of Pressure (COP), which is the result of these two variables. Another measure analyzed by its piezoelectric sensors was the distribution of loads on the plantar surface. Such measurement system has 2,288 strength sensors, arranged in rows and columns of the platform, linked to a system of data acquisition, controlled by the Research Foot 5.60 Software of TekScan, for storage and interpretation of these sensors by the computer. The signal processing was performed in the softwares Matlab v. 6.0 (Mathworks) and Origem v. 6.0 Profissionais (Microcal Software)¹¹.

In every evaluation baropodometric data were collected from the supporting surface, mean and maximum pressure, in addition to the percentage of distribution of discharge of weight on the antero-posterior and lateral plantar support of both feet. The analyses with image of points of plantar pressure and oscillations of the pressure center were measured in surface per cm² and load in Kgf.

For both evaluations (static balance and plantar pressure) we requested for each patient to remain static on the platform keeping a distance between the feet similar to the distance of their shoulders. After calibration of the system according to the body weight of the patients, they remained static in bipedal position for 60 seconds, with the head aligned, focusing a specific point fixed at 1.50 m of the wall at their eyes level¹¹⁻¹³.

The volunteers were evaluated in three different moments: without bandaging, with bandaging in the paretic ankle, and after five minutes of bandaging, considering that in this period the patient ambulated freely for 5 minutes.

Procedures for bandaging in eight

Bandaging in eight was performed at the paretic ankle, with high compression elastic bandage, from the FAMARA brand, as indicated in a previous study⁸. According to the following figure:



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Figure 1. (A) Beginning of bandaging in eight in the plantar arch. (B) Starting bandaging in eight behind the ankle. (C) Continuity of bandaging in eight positioning the ankle joint in plantar eversion and dorsiflexion. (D) Bandaging in eight concluded

Statistical Analysis

For sample characterization, we used descriptive statistics, by mean and standard deviation for the quantitative variables; frequency for categorical variables; and non-parametric variables were summarized in median and interquartile range (25% and 75%).

The Shapiro-Wilks normality test was used to verify the normality of data regarding COP and the plantar pressure distribution. COP presented parametric distribution, and thus we used ANOVA test for repeated measurements to analyze the immediate effect of bandaging in eight in the three moments evaluated (without, with, and five minutes after using the bandaging). The plantar pressure distribution proved to be a non-parametric datum, in such a way that we used the Friedman test. In all the inferential analyses we considered a risk of $\alpha=0.05$.

RESULTS

Forty individuals were screened, and four out of these were excluded by cognitive deficit, tracked by the Mini-Mental test, and six for presenting ankle contracture. We used a convenience sample composed of 30 individuals who were evaluated in the physical therapy clinics of Nove de Julho University. Clinical and demographic characteristics are elucidated in Table 1.

We did not observe statistically significant difference in plantar pressure distribution in none of the moments evaluated. The values are represented in Table 2.

Likewise, we did not observe any statistically significant difference in static balance after using the bandaging in eight in any of the moments evaluated in this study. The values are presented in Table 3.

Table 1. Clinical and demographic characteristics of the study volunteers

Variable	(n=30)
Men	23 (76.66%)
Women	7 (23.33%)
Age (years)	57.63±13.06
Time after CVA (months)	47.54±35.23
Right hemibody affected	13 (43.33%)
Left hemibody affected	17 (56.66%)

Data expressed as absolute and relative frequency and mean and standard deviation (SD) for the variables of time

Table 2. Central measurement and dispersion values referring to the plantar pressure distribution of the foot without, with, and after 5 minutes of bandaging in eight

	Without bandaging (n=30)	With bandaging (n=30)	After 5 minutes (n=30)
L Forefoot (Kgf/cm ²)	19.0 (12.0/32.2)	24.1 (9.8/33.5)	18.5 (11.3/31.8)
R Forefoot (Kgf/cm ²)	22.3 (14.2/41.6)	25.4 (15.6/39.4)	23.1 (14.4/33.5)
L Rearfoot (Kgf/cm ²)	17.1 (5.9/28.5)	16.5 (5.5/29.2)	15.2 (3.2/33.8)
R Rearfoot (Kgf/cm ²)	20.3 (15.1/40.6)	20.2 (12.6/34.1)	18.4 (12.9/37.2)

L: left; R: right. Data expressed as median and interquartile range (25%/75%). Friedman, $p>0.05$ for all variables

Table 3. Central measurement and dispersion values referring to the static balance of individuals without, with, and after 5 minutes of bandaging in eight

	Without bandaging (n=30)	With bandaging (n=30)	After 5 minutes (n=30)
AP Oscillation (mm)	20.59±3.15	21.00±3.28	20.83±3.25
ML Oscillation (mm)	26.31±5.78	26.51±5.34	25.95±6.09

mm: millimeters; AP: Antero-posterior; ML: Mean-lateral. Data expressed in mean and standard deviation. ANOVA, $p>0.05$ for all variables

DISCUSSION

The objective of this study was to determine the immediate effect of bandaging in eight on static balance and plantar pressure distribution in patients who have had CVA to verify the distribution of loads under the plantar surface without, with, and after five minutes of bandaging in eight in the ankle/foot, and the oscillations of the points of strength in relation to the speed and to the anterior-posterior and latero-lateral displacement. After analysis of the results, we observed that there was no improvement in static balance and plantar pressure distribution in patients evaluated in this study. Therefore, we assume the null hypothesis of the study.

These results resemble those reported by Simons et al.¹⁴, who evaluated the use of ankle/foot orthosis in patients post CVA, and concluded that there was improvement in functional tests, however, there was no improvement in static balance due to decrease in the internal torque of the ankle due to the reduction in the active contribution of the muscles of the ankle. Thus, we infer that the bandaging may have restricted the internal torque of the ankle, and for this reason the variables studied did not improve.

Although this study did not have any significant results, it should be noted that bandaging in eight proved to be effective in improving functional balance and gait parameters, according to the results of Torriani et al.⁷ that after assessing the number of steps, cadence, and gait speed in 12 patients with hemiparesis after CVA observed functional improvement of the individuals, using as a resource the count of the Dynamic Gait Index (DGI), performing eight functional tasks involving gait on flat surface, change in gait speed, being evaluated in two stages: one without and other with the use of bandaging in eight.

The study by Silva et al.⁸, whose aim was to evaluate the immediate effect of the use of bandaging in eight on functional balance and mobility and gait speed after CVA, showed statistically significant improvement in all the outcomes after the use of the technique. These findings did not corroborate the results presented in this study.

Even though we did not observe any statistically significant changes in static balance and plantar pressure distribution with the use of bandaging in eight, the individuals evaluated reported feeling safer during the gait and felt a better positioning of the feet with the use of the technique.

However, we highlight the limitation of this study, since we analyzed only the immediate effect of bandaging in eight. Cross-sectional studies as the one performed here do not provide causality relations. Therefore, we emphasize the need to perform longitudinal clinical studies to determine cause-and-effect relations between the variables studied.

Regardless of the limitation mentioned, the results here obtained are of extreme relevance to the field of rehabilitation for analyzing a new physical therapy resource used in post-CVA rehabilitation, and for demonstrating that only one application of bandaging in eight is not capable of retrieving the static balance and plantar distribution. Hence, the targeting of the treatment becomes more appropriate.

We also emphasize that few studies are found in the literature about the effect of bandaging in eight on post-CVA rehabilitation, which hinders or limits comparisons with the results obtained and discussion of the results. Therefore, we suggest that more studies with bandaging in eight are carried out with increased time of use and evaluation of biomechanical parameters of the ankle, for better analysis of the effect of this technique.

CONCLUSION

We concluded that a single application of bandaging in eight is not capable of generating clinical changes in static balance and plantar distribution in individuals with hemiparesis due to CVA.

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