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ORIGINAL RESEARCH

Assessment of body weight distribution in hemiparetic patients: posturographic measurements versus the Assessment of Symmetry and Weight-Transfer scale

Avaliação da distribuição do peso corporal em hemiparéticos: medidas posturográficas versus *o instrumento Avaliação da Simetria e Transferência de Peso*

Evaluación de la distribución del peso corporal en individuos hemiparéticos: medidas posturográficas versus *instrumento de Evaluación de Simetría y Transferencia de Peso*

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ABSTRACT | Asymmetry in body weight distribution (BWD) is a common post-stroke finding. Although posturography is considered the gold standard for detection of BWD asymmetry, it requires specific equipment and knowledge, which limits its use in clinical practice. The Assessment of Symmetry and Weight-Transfer (ASWT) scale is a simpler method to identify asymmetry in body weight distribution. However, it has not been tested whether its scores are related to posturographic measures. Thus, the aim of this study was to evaluate concurrent validity by the association between ASWT and the posturographic measures of BWD in individuals with hemiparesis. Sixty hemiparetic patients [median (min-max)] 58 (33-86) years-old and with 24 (6-29) months after the first stroke were evaluated. The BWD was assessed through ASWT and BWD percentage over the non-paretic limb by posturography. The median ASWT score was 23 (14-27), "partially good capacity of symmetry and weight transfer". The posturography revealed 59% BWD (50-97), a significant asymmetry to the non-paretic side. Posturography identifies a higher proportion of asymmetric individuals than the ASWT (29 vs. 8, respectively; p=0.003). There was no significant correlation between ASWT and %BWD (ρ=0.001, p=0.992). We concluded that ASWT is not related to asymmetry in the BWD estimated by posturography, suggesting the need of a reassessment of its clinical utility.

Keywords | Stroke; Paresis; Motor Activity; Postural Balance.

RESUMO | A assimetria na distribuição do peso corporal (DPC) é um achado comum após um acidente vascular cerebral. Embora a posturografia seja considerada o padrão-ouro para a detecção da assimetria da DPC, exige equipamentos e conhecimentos específicos, limitando seu uso na prática clínica. Por outro lado, a Escala de Avaliação da Simetria e Transferência de Peso (ASTP) é um método simples para identificar a assimetria na DPC. Entretanto, não foi testado se seus resultados estão relacionados às medidas posturográficas. Assim, o objetivo desse estudo foi avaliar a validade concorrente por meio da identificação do grau de associação entre a ASTP e as medidas posturográficas da DPC em indivíduos com hemiparesia. Sessenta indivíduos, com hemiparesia [mediana (min-max)] 58 (33-86) anos e 24 (6-29) meses desde o primeiro

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AVC, foram avaliados. A DPC foi avaliada por meio da ASTP e da posturografia (percentual da DPC sobre o membro não parético). A mediana do escore ASTP foi 23 (14-27), "capacidade parcialmente boa de simetria e transferência de peso". A posturografia revelou 59% de apoio do peso corporal (50-97) sobre o lado não parético. Além disso, identificou uma proporção maior de indivíduos assimétricos do que a ASTP (29 vs. 8; p=0,003). Não houve correlação significativa entre ASTP e %DPC (rho=0,001, p=0,992). Concluiu-se que a ASTP não está relacionada à assimetria na DPC estimada pela posturografia, sugerindo a necessidade de uma reavaliação de sua utilidade clínica.
Descritores | Acidente Vascular Cerebral; Paresia; Atividade Motora; Equilíbrio Postural.

RESUMEN | La asimetría en la distribución del peso corporal (DPC) es un hallazgo común tras el accidente cerebrovascular. Aunque se considera la posturografía el patrón de oro para la detección de asimetrías en la DPC, se requiere equipos y conocimientos específicos, lo que limita su uso en la práctica clínica. Por otro lado, la Escala de Evaluación de Simetría y Transferencia de Peso (ASTP) es un método sencillo para identificar la asimetría en la DPC. Sin embargo, no se ha comprobado si sus resultados están relacionados con las mediciones posturográficas. Así este estudio tuvo como objetivo evaluar la validez concurrente identificando el grado de asociación entre la ASTP y las mediciones posturográficas de la DPC en los individuos con hemiparesia. Se evaluaron a 60 individuos con hemiparesia [mediana (mín-máx)] 58 (33-86) años y 24 (6-29) meses desde el primer accidente cerebrovascular. La DPC se evaluó por medio de la ASTP y la posturografía (porcentaje de DPC en el miembro no parético). La puntuación media de la ASTP fue de 23 (14-27), "capacidad parcialmente buena de simetría y transferencia de peso". La posturografía reveló un 59% de apoyo del peso corporal (50-97) en el lado no parético. Además, identificó una mayor proporción de individuos asimétricos que la ASTP (29 vs. 8; p=0,003). No hubo una correlación significativa entre el ASTP y el %DPC (rho=0,001, p=0,992). Se concluyó que la ASTP no está relacionada con la asimetría en la DPC estimada por la posturografía, lo que sugiere la necesidad de reevaluar su utilidad clínica.
Palabras clave | Accidente Cerebrovascular; Paresia; Actividad Motora; Equilibrio Postural.

INTRODUCTION

Strokes (or cerebrovascular accidents, CVA) are one of the main causes of disability in adults[1], caused by decrease or interruption of blood flow to the brain. It damages motor, sensory and/or cognitive functions[2]. Among the motor losses, one of the most common is the decrease in muscle strength in the contralateral dimide, known as hemiparesis[3] and that, in addition to changes in postural control and spatial cognitive disorders[4], can cause difficulties in the individual's ability to lean on the paretic lower limb, with greater weight release on the non-paretic side[5-8].

Asymmetry in body weight distribution may impair orientation and stability necessary to perform activities of daily living in the standing position. In fact, studies report that, in orthostatic posture, hemiparetic individuals release approximately 58 to 63% of body weight over the non-paretic limb[9-11] (overload of about 10%). When asked to shift weight between the lower limbs, these individuals discharge only 65.5% of body weight over the paretic limb, while controls can release about 95% of the weight on the lower limbs[12]. The percentage of time spent in the gait support phase is, on average, shorter in the paretic limb (67%) when compared to non-paretic (80%)[13,14]. This is similar to what occurs during sitting and lifting, in which the paretic limb supports only 25% to 38% of body weight[15.16].

Different techniques can be used to quantify body weight balance among lower limbs: digital scales under each limb; biofeedback systems with body displacement measurement or devices that measure vertical strength during gait and orthostatic posture, using force platforms[17]. In this sense, the posturography examination uses displacement of the center of pressure (COP) of the feet as an indicator of the ability to maintain postural stability[18,19]. Methodologically, analysis of weight distribution can be performed with two force platforms, measuring the lateral displacement of the center of foot pressure[7,17,20] or the weight release on each lower limb[21,22]. However, this analysis can be carried out with only one platform, using the mean lateral position of the COP during orthostatic posture in relation to the support base of the individual, for subsequent calculation of the percentage of body weight distribution (%BWD) under each foot[9].

Although posturography is considered the gold standard measure[17], this technique requires specific equipment and technical knowledge. On the other hand, a simple and fast method is the Assessment of Symmetry and Weight Transfer (ASWT), proposed by Chagas and Tavares[23], an instrument that uses visual inspection in tasks that require static and dynamic stability. Furthermore, the ASWT is a specific instrument for assessing body symmetry that can be easily applied in clinical practice with minimal costs and easily interpreted results. In addition, the dynamic evaluation promoted by the scale is relevant for the choice of physiotherapeutic treatment for post-stroke individuals, since its application evaluates body symmetry during the transfer of active weight of the torso and pelvis in posture changes from sitting to standing and during gait; that is, typical situations of daily living. Its proponents argue that their score is directly proportional to the degree of symmetry and the level of weight transfer between the lower limbs[23]. However, the association between ASWT and gold standard measures has not yet been tested.

Thus, the objectives of this study were (1) to evaluate the distribution of body weight among the lower limps of hemiparetic patients using ASWT and posturographic measures and (2) to evaluate the concurrent validity by identifying the degree of association between the measures obtained by the two instruments.

METHODOLOGY

Participants

A total of 97 participants were recruited. To be included, the volunteer needed to have between 20 and 70 years of age; hemiparesis resulting from stroke; be able to stay in the standing position and walk independently. Volunteers with other neurological conditions and/or scores below 18 in the mini-mental state examination[24] were not included. 60 volunteers met the necessary criteria and agreed to participate in the study. All participants signed the informed consent form.

Procedures

To determine body weight distribution, each participant was submitted to a posturography examination and application of ASWT. The ASWT is composed of eight items that assess attitudes and functional transfers in the sitting, standing and gait position. The items evaluated include A: seated position (1-3 points); B: torso posture (1-3 points); C: active weight transfer of the torso and pelvis (1-3 points); D: passive lateral weight transfer of the torso (1-3 points); E: lifting from seated to standing position (1-3 points); F: standing position (1-4 points); G: torso posture (1-4 points); and H: gait (1-4 points). During the evaluation, volunteers receive points according to independence, postural deviations, the ability to actively transfer weight and head posture, in addition to the pace of gait. Total ASWT score ranges from 8 to 27: 8 being absence of symmetry and weight transfer; 10-13, minimum capacity; 14-18, moderate capacity; 19-24, partially good capacity; 25-26, good capacity; and 27, full capacity.

The posturographic examination estimated body weight balance in orthostatic posture through a single force platform (AccuSwayPLUS, AMTI, USA). Participants were invited to stand on the force platform, in a comfortable position, with the gaze fixed on a target located at eye level. Feet were positioned on a sheet of graph paper, in which the positions of the calcaneus, hallux and head of the fifth metatarsal were marked, for later determination of the dimensions of the support base of each participant. A single data collection was performed in this position for 60 seconds. The posturographic signal was obtained through the software Balance Clinic (AMTI) at a sampling rate of 50Hz.

Data analysis

Feet COP displacement was calculated using the forces and moments of force acquired by the platform. Dimensions of the support base were estimated offline by means of geometric calculations applied from the coordinates derived from anatomical landmarks of the feet (Figure 1). The support polygon was divided into small geometric figures, and each center of mass was added to provide the base global center (BOS_{CENTER}; Figure 1). The percentage of body weight distribution (%DPC) was calculated from the lateral position of the COP (COP_{ML}) in relation to the BOS_{CENTER} of each participant, using the following equation: $\%BWD=0.5 \times (COP_{ML}-BOS_{CENTER}) + 50$[9]. A correction was made in such a way that values above 50% indicated higher weight distribution on the non-paretic limb, while values below that number indicated distribution over the paretic limb. Values equal to 50% indicate symmetry in body weight distribution[25]. For example: for an individual with 100kg, a %BWD of

57% indicates a higher weight release (about 7kg) to the non-paretic side.

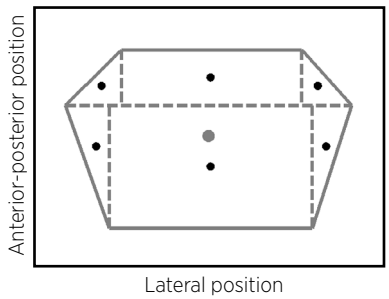

Figure 1. Graphical representation of an individual's support base (SB, continuous gray line) drawn from markers made on the graph paper sheet. The support area was estimated by the sum of the area of each of the six small geometric figures (indicated by the dotted gray lines). The center of mass of the geometric figures (small black circles) was calculated and used to obtain the center of mass of the support base (large gray circle).

Statistical analysis

The Shapiro-Wilk test revealed a non-parametric distribution of the data ($p<0.03$). Thus, these were presented as number of occurrences or as median (min-max value). To quantify the association between the ASWT score and the %BWD on the posturographic examination, the Spearman correlation coefficient (ρ) was used, with a 95% confidence interval (95%CI). In addition, the participants were classified as presenting preserved or altered BWD, according to the cutoff points of each evaluation instrument. For the ASWT scores, totals equal to or lower than 18[23] were considered as altered. For posturography, the cutoff point was equal to or greater than 10% of body weight on the non-parathetic side, corresponding to a %BWD of ≥60%[9]. The chi-square test (χ^2) was used to compare the instruments regarding the distribution of participants classified as preserved or altered body weight distribution. Statistical analyses were performed with the JASP software, version 0.8.4. The significance level was 5% ($p<0.05$).

RESULTS

The results refer to the data of the 60 participants. Clinical and demographic characteristics are presented in Table 1. The ASWT score was [median (min-max)] 23 (14-27) points, suggesting a "partially good capacity for symmetry and weight transfer". On the other hand, the %BWD was 59% (50-97), indicating an important level of asymmetry among the limbs.

Table 1. Clinical and demographic characteristics of the sample

Variables	Values
Sample size	60
Age (years)	58 (33-86)
Sex (M/F)	32/28
Time after stroke (months)	24 (6-29)
Affected hemisphere (R/L)	31/29
Type of stroke (ischemic/ hemorrhagic)	53/7
ASWT	23 (14-27)
%BWD	59 (0-97)

Data expressed as number of occurrences or median (minimum-maximum); ASWT: Assessment of Symmetry and Weight Transfer; %BWD: percentage of body weight distribution.

Through the cut-off values presented in the literature, the ASWT scores below 18 (moderate symmetry and weight transfer) and %BWD above 60%[9-11,23] were considered as indicative of altered BWD. As such, it was observed that with posturographic measurements, a greater number of participants (N=29; 48%) was classified with altered BWD when compared to the same variable (N=8, 13%) according to ASWT (χ^2=17,232, $p<0.001$). Finally, there was no significant correlation between the score obtained in the ASWT and the %BWD (ρ=0.001; CI95%=–0.253-0.255; p=0.992; Figure 2).

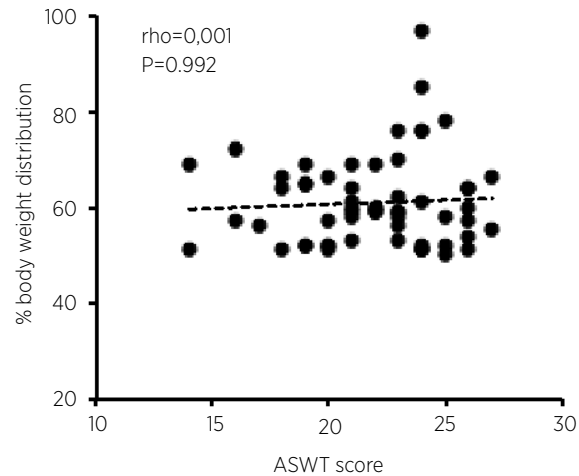

Figure 2. Scatter plot showing the relationship between the percentage of body weight distribution (%BWD) and the score in the ASWT (gray circles). The dotted black line refers to the estimated linear regression line. Spearman's correlation coefficient (ρ) and the corresponding p-value are also shown in the figure.

An additional association was tested, considering only the values for static ASWT items. However, even the "equivalent" measures (items F and G of the ASWT vs. % DPD)

did not provide a significant association between the instruments (ρ=0.025; CI95=-0.230-0.277, p=0.848).

DISCUSSION

This study aimed to evaluate the concurrent validity by identifying the degree of association between ASTP and posturographic measurements of body weight distribution among the lower limbs of individuals with hemiparesis. The results showed that a considerable proportion of the sample presented asymmetry in BWD according to the posturography examination. However, ASWT did not indicate the same result. In addition, there was no significant association between the two instruments.

Although ASWT is an easy and fast application instrument, its results had not yet been compared with a gold standard measure. In this study, the median for the ASTP score was 23, in agreement with other studies that reported scores between 19 and 23[26,27]. Interestingly, considering the cutoff point of the ASWT (≤18), only one study identified altered BWD in the population studied[28].

Although the scores were consistent with those reported in the literature, the ASWT did not detect the asymmetry in the BWD of the individuals evaluated: 29 of the 60 participants (48%) presented an altered BWD as assessed by the posturography examination. However, only 8 (13%) identified as asymmetric by the ASWT. As the ASWT evaluates asymmetry in the sitting and standing positions and during gait, while posturography does so only during orthostatic condition, the association between the values referring to static items of ASWT and %BWD was tested. However, even the "equivalent" measures did not provide a significant association between the two instruments. As such, these findings suggest that ASWT is not a valid measure for the identification of asymmetry among the lower limbs of hemiparetic patients.

Some authors have demonstrated a positive correlation between ASWT and the Modified Barthel Index (MBI)[26,28]. Trindade et al.[28] investigated the correlation between ASWT and Berg balance scale (BBS) as well as between ASWT and the modified Gait Abnormality Rating Scale (GARS-M). They observed that ASWT was strongly associated with levels of functional independence (MBI), balance (BBS) and gait (GARS-M). However, Martins et al.[27] evaluated the correlation of the ASWT score with the BWD ratio measured by means of two precision scales positioned under each lower limb. For this measure, no correlation was found, corroborating this study.

The BWD median obtained by posturography was 59%, indicating an asymmetry of about 9% of body weight for the non-paretic side. Knowing that the asymmetry index of the young and healthy population is approximately 2% and between 0-7% in older adults[29,30], it can be affirmed that at least half of the sample presented normal weight distribution, while the others presented considerable asymmetry in this variable. The values observed are in accordance with the literature, which indicates asymmetry between 8-13% in hemiparetic patients[9-11].

This study had as limitation the fact that strokes were diagnosed mostly clinically, without necessarily having been presented by the patients an imaging test that showed exactly the area affected by the ischemic event. On the other hand, the individuals were examined, and all had signs related to the syndrome of the first neuron, suggesting lesion in the pyramidal route.

Posturography is often used to evaluate the asymmetry index in BWD among the lower limbs[17]. Usually, when carried out with only one force platform, the measurement is made with the lateral position of the center of pressure, and it is not possible to calculate directly the %BWD in each limb. Genthon et al.[9] proposed that it would be possible to calculate the %BWD through a linear regression between the lateral position of the center of pressure and the %BWD predicted in each limb. These authors identified that a displacement of 10 mm in relation to the center of the platform corresponds to a 5% increase in body weight towards one of the lower limbs. This estimate[9], combined with those presented in this study, is similar to the measures observed in the literature, suggesting that this technique actually eliminates the need to use two platforms.

FINAL CONSIDERATIONS

The ASWT scale underestimated the clinical condition of post-stroke individuals and did not present significant association with the gold standard measure. These findings suggest that ASWT is not a valid measure for the identification of such conditions and cannot replace the evaluation with the use of posturographic examination.

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