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Reliability and minimal detectable change of body-weight distribution and body sway between right and left brain-damaged patients at a chronic stage

Karim Jamal ^{1 2}, Sébastien Cordillet ¹, Stéphanie Leplaideur ^{1 3}, Hélène Rauscent ¹, Mélanie Cogné ^{1 4}, Isabelle Bonan ^{1 3}

- 1 - Physical and Rehabilitation Medicine Department, University Hospital of Rennes, Rennes, France.
- 2 - M2S Laboratory - EA 1274, University of Rennes 2, Rennes, France.
- 3 - Empenn Unit U1228, Inserm, Inria, University of Rennes, Irisa, UMR CNRS 6074, Rennes, France.
- 4 - Hybrid Team, Inria, University of Rennes, Irisa, UMR CNRS 6074, Rennes, France.

Implications for rehabilitation

- Weight bearing asymmetry (WBA) and increased body sway (IBS) are highly reliable posturography parameters.
- Reliability of WBA/IBS are similar among right (RBD) and left brain damaged patients.
- A change of 5 to 7% can be interpreted as significant for WBA for chronic stroke.
- The minimal detectable change in measures is slightly higher for RBD patients.

Reliability and minimal detectable change of body-weight distribution and body sway between right and left brain-damaged patients at a chronic stage.

Abstract

Purpose: To assess the reliability and minimal detectable change (MDC) of weight-bearing asymmetry (WBA) and body sway (BS) during “eyes open” (EO) and “eyes closed” (EC) conditions for those with right (RBD) and left brain damage (LBD) at a chronic stage.

Methods: 16 RBD and 16 LBD patients participated in two sessions within 15 days, composed of two trials of 30 seconds using a double force platform. Intraclass correlation coefficient (ICC2,1), the standard error of measurement (SEM) and MDC were calculated for WBA and BS (area and velocity of sway).

Results: Reliability of WBA was excellent (> 0.75) except for EC for LBD patients (Low SEM was found). The condition of EC was similar to or less reliable than that of EO. The MDC of WBA was 5.4 and 7.3% for RBD and LBD patients, respectively. Velocity of sway should be favored over the area of sway due to better reliability, with a MDC of 9 and 13 mm/s for RBD and LBD patients, respectively.

Conclusion: Parameters related to WBA and BS were highly reliable, without a difference between RBD and LBD patients, but less so in the condition of EC, and could be used for clinical rehabilitation and/or research.

Key words: weight-bearing asymmetry, body sway, stroke, chronic, reliability, minimal detectable change

Introduction

One of the causes of disability in patients following a stroke is postural imbalance which is often evaluated in clinical practice by way of a force platform. Postural imbalance can be characterized by an insufficient weight put on the paretic leg (weight-bearing asymmetry, WBA) and shift of the center of pressure in the medio-lateral plane (MLCOP) towards the non-paretic side of the body are frequently found after a stroke [1,2]. Body sway (BS), which is defined by an area or velocity of sway, can also be found after a stroke [3]. The reliability of these parameters has been regularly assessed in the literature [2,4,5]. However, the measurements obtained for the various parameter conditions must be carefully taken. Evaluation on a double-force platform rather than a single-force platform is recommended for the measurement of WBA and the shift in the MLCOP [6]. Martello *et al.* [5] studied WBA in chronic stroke patients using a double platform and found good reliability but studied only a small population of 16 participants. This result thus requires confirmation on a larger population. The reliability of BS parameters has, to date, only been studied either on a single-force platform for chronic stroke participants [2] or a double-force platform for those in the subacute period after a stroke [4] but not on a double-force platform with participants with chronic stroke.

Reliability is usually evaluated in a relative manner by way of Intraclass Correlation Coefficient ($ICC_{2,1}$) [7]. That said, the absolute reliability assessed by standard error of measurement (SEM) is as important to be considered. Indeed, in the case of repetitive assessments, SEM is a parameter that indicates the amount of random error [8] (i.e., a lower value indicates good reliability [2]). In addition, the use of the SEM provides several advantages over relative reliability, as an estimate of reliability that includes the units of measurement can determine the minimal difference between the first and second evaluation to

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3 be considered as a true change and not just due to a test-retest error [9]. Aside from reliability,
4 the minimal detectable change (MDC) can be defined as the minimum magnitude of a change
5 which can be considered clinically significant [10]. Therefore, the determination of both the
6 relative and the absolute reliability as a threshold for the MDC for clinical rehabilitation or
7 research is crucial.
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15 Patients with right brain damage (RBD) have a poorer prognosis than those with left brain
16 damage (LBD) in terms of balance and therefore take a longer time to recover their balance
17 [11,12]. As a result, WBA and BS parameters have been found to be different between these
18 two populations [11,13,14]. Consequently, distinct MDC thresholds need to be determined
19 depending on the side of the brain lesion, along with their reliability. We aimed to test the
20 reliability of the most commonly used posturography parameters evaluated in two trials of 30
21 seconds on a double-force platform with chronic stroke patients and to determine the MDC
22 for each. The reliability and MDC were assessed separately between RBD and LBD patients.
23 Finally, we also compared the conditions of “eyes open” and “eyes closed” as the vision
24 system plays a major role in maintaining and controlling posture and that stroke population
25 have a high level of visual dependence for the control of postural balance [15,16].
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42 **Methods**

43 *Patients*

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45 The data from our previous study [17] were taken into consideration for these secondary
46 analysis. Stroke patients were recruited from the Department of Physical Medicine and
47 Rehabilitation (PMR) at the XX. The included patients all had unique right- or left-brain
48 supratentorial damage and were more than a year distant from the stroke and less than 80
49 years old. The exclusion criteria were an ischemic or hemorrhagic brainstem stroke, an
50 orthopedic and/or rheumatological history affecting the center-of-pressure distribution when
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3 standing, a visual history that did not allow assessment of their vision, and major
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5 comprehension disorders. All patients gave their informed signed consent. The original study
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7 was approved by the local ethics committee of the XX, number XX.XX (July 2012), and
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9 registered at Clinicaltrial.gov (XX). Thirty-two patients, including six women, with an
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11 average age of 60.9 ± 10 years and an average time since their stroke of 4.9 ± 4 years, divided
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13 into two groups of 16 RBD and 16 LBD patients, were included (Table 1).
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18 *Procedures*
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20 Postural assessment was performed by an experienced physiotherapist in stroke rehabilitation
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22 who was accustomed to use of the double forceplatform (PostureWin V143
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24 TechnoConcept©). Patients were tested twice with a 2 week gap between the sessions under
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26 the same conditions, in the same room, at the same time of the day, and with the same
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28 evaluator as for the first session. During both sessions, patients performed 4 trials including
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30 two with eyes open (EO) and two with eyes closed (EC) (ie. Patients were wearing a
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32 blindfold). Patients received no additional rehabilitation outside of their regular
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34 physiotherapy treatment between the sessions.
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39 Patients stood on the platform in their bare feet with their feet parallel and 14 cm apart, with
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41 instructions to stand as straight as possible with their arms alongside their body while looking
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43 straight ahead. The percentage of the weight put on the non-paretic limb (WBA), mean
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45 mediolateral (MLCOP) and anteroposterior position (APCOP) of the center of pressure (mm),
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47 body sway composed of either area of sway (mm^2) or velocity of sway in the medio-lateral
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49 plane (mm/s) were calculated as the mean of the two trials with eyes open (EO) and then
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51 another mean for the other two trials with eyes closed (EC). These two means were
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53 averaged out to obtain the overall mean for the four trials. Each trial lasted 30s. It is
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55 recommended to take longer single measurements [18]. However, if measurements of shorter
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duration are taken, it is suggested to average several force platform recordings [18]. We chose to carry out repeat trials of 30s each, with a rest period in between, to avoid fatigue.

Statistical analysis

The reliability of posturography parameters were analyzed using the intraclass correlation coefficient for a single random rater (ICC_{2,1}). ICC estimates were interpreted based on the following guidelines: <0.5 indicates poor reliability, 0.5-0.75 indicates moderate reliability, 0.75-0.9 indicates good reliability, and >0.9 indicates excellent reliability [7]. Reliability was interpreted considering the 95% confidence interval. The standard error of measurement (SEM) was determined using the following equation: $SEM = SD \times \sqrt{1 - ICC}$. The minimum detectable change (MDC) was determined using the following equation: $MDC_{95} = 1.96 \times SEM \times \sqrt{2}$. Non-parametric paired t-test was used to examine statistical significance of differences between sessions for each outcome.

The agreement between the two sessions of each outcome was assessed using the Bland-Altman plot method by plotting the mean test-retest scores on the x-axis and the test-retest difference on the y-axis. The 95% CI of the mean difference represented as boundary lines illustrates the magnitude of the systematic difference. The graphical interpretation was useful for identifying systematic changes between sessions and for illustrating heteroscedasticity, with increasing/decreasing variability with increasing mean test-retest values.

To compare conditions reliability (EO vs. EC), non-parametric paired t-test were performed using the test-retest differences. To assess the effect of brain lesions on reliability, non-parametric t-test were performed using the test-retest differences.

The alpha was set to 0.05 for all data analyses. Statistical analysis was performed using RStudio v. 1.3.959 statistical software [19].

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Results (Table 2)

Figure 1 graphically presents the test-retest difference between EO and EC for LBD and RBD patients as well as the 95% CI which can be found in Table 2. ICC, SEM and MDC are also available in Table 2.

Weight bearing asymmetry (WBA)

Regarding LBD patients, we found no difference in WBA between the condition EO and EC ($p=0.09$). Equally, no difference was observed between the test and retest in EO conditions ($p=0.7$) while the test and retest in EC showed significant difference ($p=0.04$). Reliability of the WBA measurements were good in EO (ICC=0.86 95%CI (0.71; 0.91)), whereas moderate for the condition of EC (ICC=0.68 95%CI (0.39; 0.85)). All data concerning the SEM are presented in Table 2. The MDC95 scores of WBA were 5.4% and 8% for EO and EC, respectively for this population.

For RBD patients, no difference was found neither between the eyes conditions ($p=0.2$) nor between the test-retest (Table 2). Reliability of the WBA measurements were good to excellent (ICC=0.87-0.95). The MDC95 scores of WBA were 6 and 9.6 % for EO and EC, respectively.

Concerning the reliability of WBA between RBD and LBD, no difference was reported in patients ($p=0.92$). The Bland-Altman plot (Fig.1) showed the narrow 95% limits of agreement to be visually for LBD patients (-6.3%; 3.9%) relative to RBD patients (-8.3%;6.6%).

Mediolateral (MLCOP) and anteroposterior (APCOP) position of the center of pressure

Regarding LBD patients, while we found a difference in MLCOP between the condition EO and EC ($p=0.02$), no difference for APCOP ($p=0.11$) was established. Conversely no difference was observed between the test and retest in EO conditions neither for MLCOP nor for APCOP ($p=0.8$) whereby the test and retest in EC for MLCOP showed significant difference ($p=0.003$). Reliability of the MLCOP and APCOP measurements were moderate to good ($ICC=0.59-0.88$). All data concerning the SEM are presented in Table 2. The MDC95 scores for MLCOP were 17.7 and 23 mm and for APCOP 19.3 and 26.7 mm for EO and EC, respectively.

For RBD patients, for both MLCOP and APCOP, no difference was found neither between the eyes conditions nor between the test and retest (Table 2). Reliability of the MLCOP measurements was good to excellent ($ICC=0.85-0.92$) whereas reliability of the APCOP was poor to moderate ($ICC=0.33-0.56$). All data concerning the SEM are presented in Table 2. The MDC95 scores for MLCOP were 25.3 and 19.3 mm and for APCOP 30 and 39 mm for EO and EC, respectively.

Concerning measurements between RBD and LBD patients, there was no significant difference in the reliability of both MLCOP and APCOP (Table 2). For MLCOP measurements the Bland-Altman plot (Fig.1) showed wider 95% limits of agreement for RBD patients (-16;23 mm) than LBD patients (-8;15 mm) equally for APCOP measurements with a wider 95% limits of agreement for RBD (-35.9 mm; 31.0 mm) than LBD patients (-21.8 mm; 23.3 mm) (Fig.1).

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Body sway

Regarding LBD patients, we found no difference in BS between the condition EO and EC as well as between the test and retest (Table 2). Reliability of the velocity of sway measurement was good to excellent (ICC=0.82-0.92), whereby that of the area of sway was poor to moderate (ICC=0.44-0.72). The MDC95 score of velocity of sway were 9.9 and 21.6 mm/s and the area of sway 268 and 932 mm² for EO and EC, respectively.

Regarding RBD patients, we found no difference in BS between the condition EO and EC (Table 2) whereas a difference was observed for velocity of sway for the condition of EO (p=0.03) and EO and EC (p=0.01). Reliability of the velocity of sway measurement was good to excellent (ICC=0.82-0.9), whereby that of the area of sway was poor to moderate (ICC=0.49-0.61). The MDC95 score of velocity of sway were 7.9 and 13 mm/s and the area of sway 229 and 381 mm² for EO and EC, respectively.

Concerning the reliability of either velocity or area of sway between RBD and LBD patients, there was no significant difference (p=0.34). The Bland Altman plot of velocity of sway showed visually narrower 95% limits of agreement for RBD (-5.0; 10.6 mm/s) than LBD patients (-12.3; 14.6 mm/s). The Bland-Altman plot for the area of sway showed narrowed 95% limits of agreement for RBD (-360; 383.35 mm²) than LBD patients (-477.6; 596.1 mm²)(Fig.1).

Discussion

We aimed to test the reliability of posturography parameters on a double-force platform used in clinical practice in a stroke population, as well as determining the MDC. This is the first study conducted to compare the reliability of posturography parameter measurements between

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3 RBD and LBD patients. Our results show excellent reliability for WBA measurements for
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5 both RBD and LBD patients, with the exception of the EC condition for LBD patients, which
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7 was found to be moderate. Nonetheless, we found no significant difference between the two
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9 populations. Our results confirm those of previous studies on stroke patients in which the side
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11 of the brain damaged was not considered [5,20]. As already mentioned, we found excellent
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13 reliability of WBA, although the interval between the two sessions was longer than that in the
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15 current literature (i.e. 2 weeks) [5]. We also found the reliability of the MLCOP measurement
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17 to be excellent, with again the exception of the EC condition for LBD patients. Given that the
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19 parameters of WBA and MLCOP are related [21], such results are not surprising. Although
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21 our results confirm those of Martello *et al.* [5], they differ from those of other studies, which
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23 found weaker reliability for this parameter, likely due to various reasons, such as the stage of
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25 recovery (subacute versus chronic stroke) [4], the platform used (single versus double
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27 platform) [2], the longer duration (10s versus 30s)[4], and larger distance between the feet
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29 (3cm versus 14cm)[2]. Reliability of the APCOP measurement was also found to be excellent
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31 for LBD patients, whereas that of RBD patients was only moderate to poor. However, there
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33 was no significant difference between the two populations. Our results differ from those of
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35 Martello *et al.*[5], who found excellent reliability for this parameter. One possible explanation
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37 is the ratio of LBD patients, as most of the patients of the study of Martello *et al.* were LBD
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39 patients (11 of 16). Indeed, our results concerning reliability of the measurements for LBD
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41 participants are close to theirs, whereas our results show greater variability for the
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43 anteroposterior position of the COP in RBD patients.
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53 Concerning Body sway, reliability of the velocity of sway measurement was also excellent for
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55 both RBD and LBD patients, without any significant difference between the two populations.
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57 Our results are in accordance with those of the literature [2,4]. Despite an excellent ICC of
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velocity of sway for RBD, the test-retest comparison showed a small but significant decrease in the retest. We therefore suggest interpreting the difference in velocity of sway in the RDB population with caution. We found the area of sway to be the least reliable posturography parameter, regardless of the side of the lesion. This last result confirms that this parameter is not particularly reliable for establishing body sway in stroke patients. Indeed, both Gasq *et al.* [2], who used a single platform, and Gray *et al.* [4], who used a double force platform with subacute patients, favored velocity of sway rather than the area of sway when considering BS.

We found the EC condition to be generally less reliable than the EO condition, without the difference being significant, except for WBA for LBD patients. This difference in favor of having the EO has often been reported for healthy subjects [22,23] and our results confirm previous work on stroke patients assessed using a single force platform [2]. Although there was no significant difference between the two conditions, reliability with eyes closed was lower for most of the parameters due to the excessive reliance on visual information reported for stroke patients [24]. There was no statistical difference found between RBD and LBD patients. Both groups tended to have lower reliability scores for most of the posturography parameters with the EC than with the EO, except for WBA and MLCOP. The difference was surprisingly small between the two conditions among RBD patients. Although still relevant, such a difference could be explained by an asymmetrical postural behavior of this population independently of whether the eyes are open or closed.

Aside from the relative reliability (ICC), the absolute reliability assessed using the SEM and the Bland and Altman plots are important to consider (Table 2). Indeed, the SEM, as previously described, is as an estimate of reliability that can determine the minimal difference between two evaluations to be considered as a true change and not just due to test-retest error [9]. The SEM for WBA was in accordance with those previously observed in the literature [5] (i.e., a low SEM value remains satisfactory when established by the Bland and Altman plot)

(Table 2). Additionally, the SEM reported in this study is fairly consistent between the different measures for WBA. Therefore, although some ICC range may be large such as the one of LBD patients in the EC condition, the SEM remains low and thus the reliability considered as acceptable. Regarding the absolute reliability for BS, it was found acceptable only for velocity of sway and poor to moderate for the area of sway. Our results can only be compared to those of Gray *et al.* [4], who assessed both the area and velocity of sway using a double force platform. Although these authors included patients at a subacute stage, our results are in accordance with theirs, as they also concluded that the area of sway should be considered the least reliable parameter. Interestingly, our study highlights the larger limits of agreement of reliability for RBD patients for WBA and MLCOP. These results again reveal the pronounced asymmetrical postural behavior of RBD patients relative to that of LBD patients in terms of balance [11,12].

Following stroke, postural imbalance, evaluated by way of a force platform, can be characterized by insufficient weight on the paretic leg associated or not to body sway [1,3]. Those characteristics of postural imbalance are often associated with level of independent self-care and length of hospital stay [25]. Physical therapy is known to improve these outcome measures [26]. Thus, providing a threshold of MDC of both WBA and BS is of interest for both the follow-up of patients in rehabilitation and in interpreting the effectiveness of a postural balance treatment. A change of WBA of 7.3% for RBD patients and 5.4% for LBD patients can be considered a true change. Our results confirm those of Martello *et al.* [5] for their data on LBD patients. However, we provide a MDC according to the side of the lesion. Our results reveal a higher MDC for RBD patients. The MDC for RBD patients was higher than that for LBD patients in the EO condition and less in the EC condition, possibly due to a higher reliance on visual information by LBD patients. However, such a higher

threshold for patients with RBD translates into greater variability of the postural parameters for RBD patients.

Concerning the MDC of MLCOP and APCOP, our results can only be compared to those of Martello *et al.* [5], who used the same methodology and studied a similar population. However, our MDC values were higher. There are several possible reasons for this finding, such as the absence of considering the side of the lesion or identification of the condition of the eyes in their study. The MDC values for MLCOP and APCOP were both higher in the group of RBD patients and of greater amplitude in the EC condition, thus confirming the result for WBA. This is the first study to determine the MDC for the parameters of BS using a double-force platform. However, due to the low reliability of the area of sway measurement, we suggest using velocity of sway rather than the area of sway in clinical rehabilitation. An average threshold of 9.2 and 13.0 mm/s for RBD and LBD patients, respectively, can be considered a true change.

This study had several limitations. Although 32 subjects were included, the number of RBD and LBD patients was still low, and the number of inclusions will need to be increased in future studies to confirm our results in RBD and in LBD participants. The inter-rater reliability was not assessed in this experiment and should be tested in future studies. Finally, this study focused on subjects in the chronic phase and it would be of interest to replicate it with subjects at an acute phase after stroke.

Conclusion

This study confirms the high reliability of WBA and MLCOP for both RBD and LBD patients, except in the EC condition for LBD patients. Equally, the reliability of APCOP was found to be excellent for LBD patients, whereas it was only moderate to poor for RBD

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3 patients. We found no significant difference in the reliability of the parameters between RBD
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5 and LBD patients. The EC condition was found to be similar to or less reliable than the EO
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7 condition, probably due to the excessive reliance on visual information reported for stroke
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9 patients. The MDC for WBA of 5.4% for LBD and 7.3% for RBD patients can be interpreted
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11 as a true change. Due to better reliability, velocity of sway should be favored over the area of
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13 sway, with a MDC of 9.2 mm/s for RBD patients and 13 mm/s for LBD patients as a true
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25 grant and support
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30 **Declaration of conflict of interest**

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32 The authors declare that they have no competing interests.
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References

[1]Genthon N, Rougier P, Gissot A-S, Froger J, Péliissier J, Pérennou D. Contribution of each lower limb to upright standing in stroke patients. *Stroke J Cereb Circ.* 2008;39(6):1793-9.

[2] Gasq D., Labrunée M., Amarantini D., Dupui P., Montoya R., Marque P. Between-day reliability of centre of pressure measures for balance assessment in hemiplegic stroke patients. *J NeuroEngineering Rehabil.* 2014;11.

[3] Nichols DS. Balance retraining after stroke using force platform biofeedback. *Phys Ther.* 1997;77(5):553-8.

[4] Gray VL, Ivanova TD, Garland SJ. Reliability of center of pressure measures within and between sessions in individuals post-stroke and healthy controls. *Gait Posture.* 2014;40(1):198-203.

[5] Martello SK, Boumer TC, Almeida JC de, Correa KP, Devetak GF, Faucz R, et al. Reliability and minimal detectable change of between-limb synchronization, weight-bearing symmetry, and amplitude of postural sway in individuals with stroke. *Res Biomed Eng.* 2017;33(2):113-20.

[6] Rougier PR, Coquard T, Paillard T, Ankaoua C, Dury J, Barthod C, et al. Standing on a Double-Seesaw Device is an Easy Way to Modify the Coordination Between the Two Feet for Controlling Upright Stance: Assessment Through Weight-Bearing Asymmetry. *Motor Control.* 2020;1-14.

[7] Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J Chiropr Med.* 2016;15(2):155-63.

[8] Liuzzo DM, Peters DM, Middleton A, Lanier W, Chain R, Barksdale B, et al. Measurements of Weight Bearing Asymmetry Using the Nintendo Wii Fit Balance Board Are Not Reliable for Older Adults and Individuals With Stroke. *J Geriatr Phys Ther* 2001. 2017;40(1):37-41.

[9] Russek L. Factors Affecting Interpretation of Reliability Coefficients. *J Orthop Sports Phys Ther.* 2004;34(6):9.

[10] Haley SM, Fragala-Pinkham MA. Interpreting change scores of tests and measures used in physical therapy. *Phys Ther.* 2006;86(5):735-43.

[11] Rode G, Tiliket C, Boisson D. Predominance of postural imbalance in left hemiparetic patients. *Scand J Rehabil Med.* 1997;29(1):11-6.

[12] Pérennou D. Weight bearing asymmetry in standing hemiparetic patients. *J Neurol Neurosurg Psychiatry.* 2005;76(5):621.

[13] Jamal K, Leplaideur S, Rousseau C, Chochina L, Moulinet-Raillon A, Bonan I. Disturbances of spatial reference frame and postural asymmetry after a chronic stroke. *Exp*

Brain Res. 2018;236(8):2377-85.

[14] Fernandes CA, Coelho DB, Martinelli AR, Teixeira LA. Right cerebral hemisphere specialization for quiet and perturbed body balance control: Evidence from unilateral stroke. *Hum Mov Sci.* févr 2018;57:374-87.

[15] Bonan I, Colle FM, Guichard JP, Vicaut E, Eisenfisz M, Tran Ba Huy P, et al. Reliance on visual information after stroke. Part I: Balance on dynamic posturography. *Arch Phys Med Rehabil.* 2004;85(2):268-73.

[16] Marigold DS, Eng JJ. The Relationship of Asymmetric Weight-bearing with Postural Sway and Visual Reliance in Stroke. *Gait Posture.* 2006;23(2):249-55.

[17] XXX

[18] Van der Kooij H, Campbell AD, Carpenter MG. Sampling duration effects on centre of pressure descriptive measures. *Gait Posture.* 2011;34(1):19-24.

[19] RStudio Team, RStudio: Integrated Development Environment for R, RStudio, PBC., Boston, MA, 2020. <http://www.rstudio.com/>.

[20] Eng J, Chu K. Reliability and comparison of weight-bearing ability during standing tasks for individuals with chronic stroke. *Arch Phys Med Rehabil.* 2002;83:1138-44.

[21] Genthon N, Gissot A-S, Froger J, Rougier P, Pérennou D. Posturography in patients with stroke: estimating the percentage of body weight on each foot from a single force platform. *Stroke J Cereb Circ.* 2008;39(2):489.

[22] Santos BR, Delisle A, Larivière C, Plamondon A, Imbeau D. Reliability of centre of pressure summary measures of postural steadiness in healthy young adults. *Gait Posture.* 2008;27(3):408-15.

[23] Ruhe A, Fejer R, Walker B. The test-retest reliability of centre of pressure measures in bipedal static task conditions--a systematic review of the literature. *Gait Posture.* 2010;32(4):436-45.

[24] Bonan I, Derighetti F, Gellez-Leman M-C, Bradaï N, Yelnik A. [Visual dependence after recent stroke]. *Ann Réadapt Médecine Phys Rev Sci Société Fr Rééduc Fonct Réadapt Médecine Phys.* 2006;49(4):166-71.

[25] Sackley C.M. The relationships between weight-bearing asymmetry after stroke, motor function and activities of daily living. *Physiother Theory Pract.* 1990;6:179-85.

[26] Hugues A, Di Marco J, Ribault S, Ardaillon H, Janiaud P, Xue Y, et al. Limited evidence of physical therapy on balance after stroke: A systematic review and meta-analysis. *PloS One.* 2019;14(8):e0221700.

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Figure legend

Figure 1. Bland–Altman plots of test–retest differences (vertical scale) relative to mean test–retest value (horizontal scale). The solid line indicates the mean difference and dashed lines indicate the 95% limits of agreement. Grey dots for eyes open and black dots for eyes closed RBD: right brain damage, LBD: left brain damage, COP: center of pressure, APCOP: anteroposterior position of center of pressure, Area of Sway (AS), Velocity of sway (VS), WBA: weight-bearing asymmetry (WBA)

Figure 1 Alt Text: Figure composed of 10 graphical Bland–Altman plots of test-retest differences depending of the eyes condition of right and left brain damage patients.

Table 1. Clinical data of the patients in the study [17].

	RBD (n=16)	LBD (n=16)	p
Male/Female	14/2	12/4	-
Ischemic /hemorrhagic	9/7	12/4	-
Age (Years)	62.1 (11.3)	59.8 (10.2)	0.5
Delay-post (Years)	5.27 (4)	4.71 (4)	0.7
Motricity (/100)	69 (16)	71 (17)	0.7
Sensitivity (/6)	4 (1)	5 (1)	0.1
Visuo-spatial neglect	11/16	0/16	-
Hemianopia	0/16	0/16	-
WBA (%)	34.05 (9.4)	39.4 (4.5)	0.05
MLCoP (mm)	42.3 (23.7)	-25.2 (13.2)	<0.01
APCoP (mm)	30.7 (14.6)	36.6 (16.9)	0.3
Velocity of Sway (mm/s)	23.8 (9.3)	25.2 (14.4)	0.9
Area of Sway (mm ²)	332 (125)	364 (374)	0.8
TUG (sec)	26 (17)	24 (18)	0.7
BBS (/56)	43 (8)	42 (11)	0.7

RBD: right brain damage, LBD: left brain damage (LBD), COP: center of pressure, APCOP: anteroposterior position center of pressure, BBS: Berg Balance Scale, MLCOP: mediolateral position of center of pressure, TUG: timed up and go, WBA: weight-bearing asymmetry

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Table 2. Reliability and minimal detectable change for patients with right brain damage and those with left brain damage.

	Side Lesion	Conditions	ICC 95%CI	SEM	MDC95	test-retest 95%CI	test-retest	p.value open- closed eyes	left-right brain damage
WBA (%)	LBD	EO	0.86 (0.71 ; 0.94)	1.95	5.4	-0.27(-5.9;5.37)	0.744	-	0.75
		EC	0.69 (0.39 ; 0.85)	2.89	8	-2.07(-9.3;5.15)	0.038	0.09	0.55
		Total	0.85 (0.67 ; 0.93)	1.94	5.37	-1.17(-6.27;3.94)	0.074	-	0.92
	RBD	EO	0.87 (0.71 ; 0.94)	3.46	9.6	-0.46(-10.47;9.56)	0.669	-	-
		EC	0.95 (0.88 ; 0.98)	2.2	6.09	-1.23(-7.11;4.65)	0.093	0.21	-
		Total	0.92 (0.82 ; 0.97)	2.64	7.31	-0.86(-8.32;6.6)	0.348	-	-
MLCOP (mm)	LBD	EO	0.88 (0.74 ; 0.95)	4.95	13.71	0.64(-13.66;14.94)	0.821	-	0.32
		EC	0.59 (0.25 ; 0.81)	8.31	23.03	6.67(-13.19;26.54)	0.003	0.029	0.92
		Total	0.87 (0.72 ; 0.94)	4.58	12.7	3.57(-7.61;14.74)	0.029	-	0.66
	RBD	EO	0.85 (0.68 ; 0.93)	9.15	25.36	2.86(-23.06;28.78)	0.323	-	-
		EC	0.92 (0.81 ; 0.96)	6.97	19.32	4.22(-14.14;22.58)	0.13	0.43	-
		Total	0.91 (0.79 ; 0.96)	7.16	19.86	3.74(-15.65;23.13)	0.159	-	-
APCOP (mm)	LBD	EO	0.86 (0.71 ; 0.94)	6.97	19.31	1.46(-18.55;21.47)	0.821	-	0.36
		EC	0.75 (0.49 ; 0.89)	9.63	26.7	0.03(-27.89;27.94)	0.86	0.11	0.75
		Total	0.83 (0.63 ; 0.92)	7.78	21.56	0.74(-21.78;23.26)	0.98	-	0.44
	RBD	EO	0.56 (0.2 ; 0.79)	10.82	30	-2.33(-33.23;28.58)	0.404	-	-
		EC	0.33 (-0.09 ; 0.65)	14.11	39.12	-2.57(-42.85;37.71)	0.597	1.00	-
		Total	0.47 (0.09 ; 0.74)	11.73	32.51	-2.46(-35.92;31.01)	0.433	-	-
Velocity of Sway (mm/s)	LBD	EO	0.92 (0.83 ; 0.97)	3.6	9.99	-0.31(-10.77;10.14)	0.821	-	0.08
		EC	0.82 (0.62 ; 0.92)	7.82	21.67	3.15(-18.62;24.92)	0.528	0.49	0.59
		Total	0.89 (0.76 ; 0.95)	4.7	13.02	1.16(-12.28;14.6)	0.756	-	0.17
	RBD	EO	0.9 (0.77 ; 0.96)	2.87	7.95	2.19(-4.87;9.24)	0.034	-	-

		EC	0.82 (0.62 ; 0.92)	4.82	13.35	2.95(-9.68;15.59)	0.065	0.94	-
		Total	0.87 (0.71 ; 0.94)	3.31	9.18	2.77(-5.04;10.58)	0.013	-	-
Area of Sway (mm ²)	LBD	EO	0.72 (0.44 ; 0.87)	96.95	268.72	9.45(-270.7;289.59)	0.144	-	0.86
		EC	0.44 (0.05 ; 0.72)	336.5	932.8	109.02(-835.94;1053.97)	0.94	0.98	0.30
		Total	0.59 (0.25 ; 0.81)	190.3	527.53	59.23(-477.64;596.1)	0.821	-	0.34
	RBD	OE	0.61 (0.27 ; 0.81)	82.84	229.61	33.82(-195.68;263.33)	0.298	-	-
		CE	0.59 (0.24 ; 0.8)	137.7	381.55	64.69(-311.01;440.39)	0.211	0.40	-
		Total	0.49 (0.11 ; 0.75)	129.1	357.89	11.47(-360.41;383.35)	0.144	-	-

RBD: right brain damage, LBD: left brain damage, COP: center of pressure, APCOP: anteroposterior position of center of pressure, EC: eyes closed, EO: eyes open, ICC: intraclass correlation coefficient, MLCOP: mediolateral position of center of pressure, SEM: standard error of measurement, WBA: weight-bearing asymmetry (WBA)

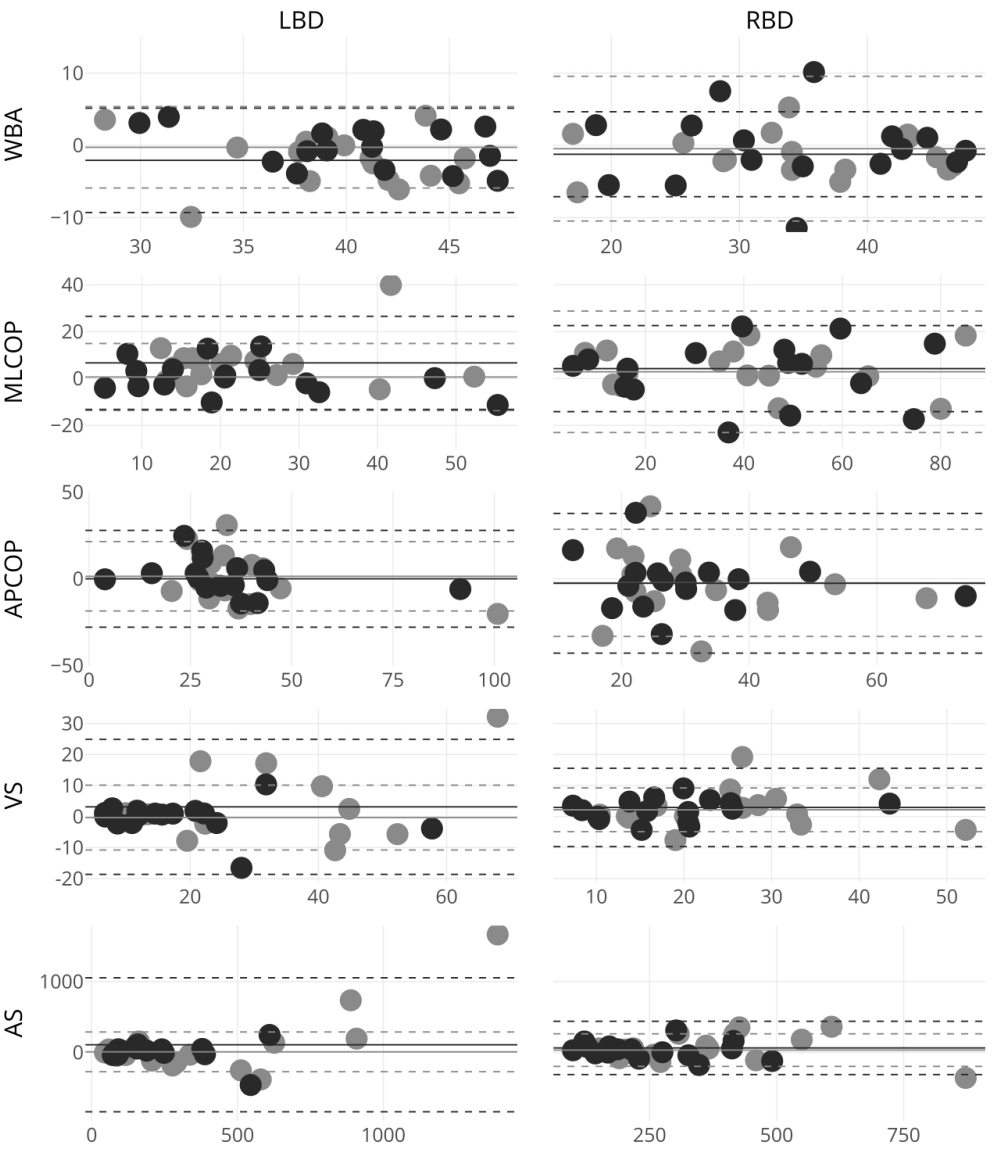


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Figure 1 Alt Text : Figure composed of 10 graphical Bland–Altman plots of test-retest differences depending of the eyes condition of right and left brain damage patients.

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