Gait & Posture 68 (2019) 514–517

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Short communication

A new cutoff score for the Burke Lateropulsion Scale improves validity in the classification of pusher behavior in subactue stroke patients

Jeannine Bergmann[a,b,*], Carmen Krewer[a], Friedemann Müller[a,b], Klaus Jahn[a,b]

[a] Schoen Klinik Bad Aibling, Kolbermoorer Strasse 72, 83043 Bad Aibling, Germany
[b] German Center for Vertigo and Balance Disorders (DSGZ), Ludwig-Maximilians-University of Munich, Marchioninistr. 15, 81377 Munich, Germany

ARTICLE INFO

Keywords:
Pusher behavior
Balance
Lateropulsion
Stroke
Validation

ABSTRACT

Background: Pusher behavior substantially hampers balance during sitting, standing, and posture transitions in stroke patients. The Burke Lateropulsion Scale (BLS) was recommended to evaluate pusher behavior. However, its cutoff score has not been validated and recent studies found evidence for a need to modify it. As there is no gold standard for the diagnosis of pusher behavior, functions that are typically disturbed in these patients should be used for the validation of the cutoff score.

Research question: To investigate whether pusher behavior correlates with balance performance during sitting, standing and posture transitions, and to validate the BLS cutoff score.

Methods: 44 subacute stroke patients with pusher behavior (BLS ≥ 2) were included in this study. The BLS and the Performance-Oriented Mobility Assessment Balance subscale (POMA-B) were assessed several times at intervals of two weeks resulting in a total of 137 data sets.

Results: Correlation analysis between the BLS score and the POMA-B score revealed a moderate negative correlation (r_{Sp} = -0.602, $p < 0.001$): The lower the BLS score, the higher the balance performance. The maximum Youden Index (J = 0.864) was found for a cutoff score ≥2.5. Patients with a BLS score ≥2 scored ≥1 on the POMA-B, while patients with a BLS score ≥3 scored at no item or only at the sitting balance task.

Significance: In line with previous findings, the results of this study support using a BLS cutoff score of ≥3 instead of ≥2 to diagnose PB for research purposes and intervention planning. A score ≥3 correlates with severe balance impairments and with an impaired verticality perception in the frontal plane, and it improves the agreement with the Scale for Contraversive Pushing.

1. Introduction

Pusher behavior (PB) is a severe disorder of postural control following stroke and reflects an altered perception of body orientation in space [1–3]. Patients with PB typically push themselves away from their non-paretic body side and resist any attempt to transfer weight over this body side [4]. Depending on its severity, PB substantially hampers different postures (sitting, standing, lying) and posture transitions.

The Scale for Contraversive Pushing (SCP) and the Burke Lateropulsion Scale (BLS) are the most commonly used clinical scales to evaluate PB. In a recent systematic review, the BLS was recommended for identifying PB and lateropulsion [5]. The scale includes a wide array of functional testing positions and its score reflects the progress most patients make during rehabilitation ranging from very severe PB which compromises sitting, standing, and possibly lying positions to mild lateropulsion which affects mainly walking. Previous studies generally used a cutoff score ≥2 to diagnose PB with the BLS. However, this cutoff has not been validated and shows moderate agreement with the SCP in the classification of PB [6]. As there is no gold standard for the diagnosis of PB, other functions that are typically disturbed in these patients should be used for the validation of the diagnosis. In a recent study, we found a correlation of a cutoff score ≥3 with an ipsilesional deviation of the subjective postural vertical (SPV) in the frontal plane [1]. As PB primarily affects postural control, measures of balance performance may also be appropriate to validate the cutoff [5]. In this investigation, we aimed to investigate whether the BLS score correlates with balance performance during sitting, standing and posture transitions, and to validate the BLS cutoff score.

* Corresponding author at: Schön Klinik Bad Aibling, Kolbermoorer Strasse 72, 83043 Bad Aibling, Germany.
E-mail addresses: jbergmann@schoen-kliniken.de (J. Bergmann), ckrewer@schoen-kliniken.de (C. Krewer), fmueller@schoen-kliniken.de (F. Müller), kljahn@schoen-kliniken.de (K. Jahn).

https://doi.org/10.1016/j.gaitpost.2018.12.034
Received 16 January 2018; Received in revised form 20 December 2018; Accepted 25 December 2018

2. Methods

Subacute stroke patients with PB (BLS ≥ 2) were included in the study. It is a secondary analysis including patients who had been recruited for two intervention trials and tested at several time points (multiple measures) at intervals of two weeks. The trials were performed in the same rehabilitation hospital and approved by the local Ethics Committee. All participants or their legal representatives gave written informed consent.

PB was assessed with the BLS. The BLS rates the patient's resistance to passive supine rolling, to passive postural correction when sitting and standing, and to assistance during transferring and walking. [7] The greater the resistance, the higher the score (range 0–17). Balance performance was rated by using the Performance-Oriented Mobility Assessment Balance subscale (POMA-B) [8,9]. The POMA-B evaluates balance in daily activity related tasks during sitting, standing, and posture transitions. The better balance performance, the higher is the score (range 0–16). Both scales were assessed within the same session by the same trained therapist.

The Spearman's rank-order correlation was used to determine the strength of the relationship between the BLS and the POMA-B scores. In addition, a Receiver Operating Characteristic (ROC) curve analysis was performed to estimate the area under the curve (AUC) and the Youden Index.

The analyses were performed using IBM SPSS Statistics (Version 19.0). The significance level for α was set at 0.05.

3. Results

We included 44 patients (71 ± 10 years old, 8.7 ± 5.0 weeks since stroke, 21 females). At the first study visit, the median BLS score was 6 (IQR 3–9) and the median POMA score 0 (IQR 0–1). Correlation analysis between the BLS score and the POMA-B score revealed a moderate negative correlation (r_{Sp} = -0.602, $p < 0.001$): The lower the BLS scores, the higher the POMA-B scores (Fig. 1).

In the course of the intervention studies, seven patients were tested once, three were tested twice, twelve were tested three times, and 22 were tested four times at intervals of two weeks, resulting in a total of 137 data points. A scatter plot of all 137 data points is presented in Fig. 2. It shows that BLS scores of 2, which just resulted in the classification of PB when using the original cutoff, led to POMA-B scores between 1 and 4. Similar, patients with a BLS score < 2 (no PB) scored ≥1 on the POMA. Consequently, patients with a BLS score ≤2 were all at least able to sit steadily and safely and most of them were even able to perform position changes or standing tasks. By contrast, BLS scores ≥3 resulted in scores ≤1 on the POMA (with one exception). That means patients with a BLS score ≥3 were at most able to perform the sitting task. All other items, evaluating standing or posture transitions, were scored 0, indicating that the tasks were not possible or unsteady.

As a POMA score ≤1 reflects severe balance impairments during standing, postural transitions, and possibly during sitting, we used a score of 1 to categorize balance performance for the ROC analysis. The ROC curve is presented in Fig. 3. The maximum Youden Index (J = 0.864) was found when using a BLS cutoff score of ≥2.5 (sensitivity = 0.932, specificity = 0.947).

4. Discussion

In the present study, we assessed the BLS along with the POMA-B in order to determine a correlation between PB and balance impairments during sitting, standing, and posture transitions and to validate the BLS cutoff score. We found a moderate negative correlation between the two scales: The lower the BLS score, the better the balance performance. This is consistent with Clark et al. [10] who found a moderate negative correlation between the BLS score and the Postural Assessment Scale for Stroke.

Originally, a BLS cutoff ≥2 was suggested for the classification of PB [11]. However, our results indicate that balance performance in patients with a BLS score of 2 has more similarity with balance performance of patients who recovered from PB than with that of patients showing PB and a BLS score > 2. The Youden Index revealed that a BLS cutoff score of > 2 results in the highest sensitivity and specificity to predict severe balance impairments during standing and postural transitions in patients with PB. In line with previous findings, these results support using a BLS cutoff score of > 2 [1,6]. Recently, we found an improved agreement between the BLS and the SCP (cutoff > 0

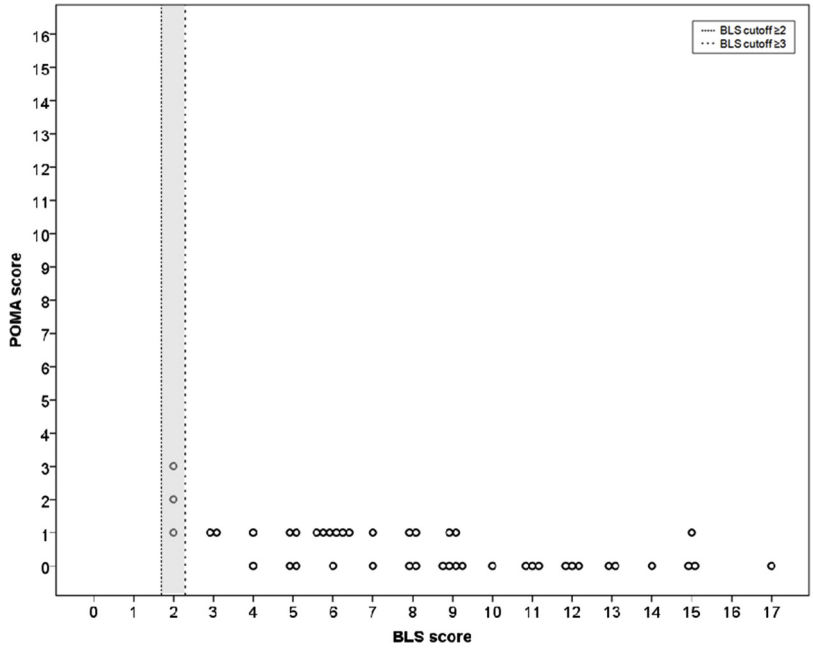

Fig. 1. Scatter plot showing the BLS scores and the POMA scores at first study visit (n = 44). The gray area marks data sets with a BLS score of 2, which just resulted in the classification of PB when using the original cutoff.
POMA-B, Performed Oriented Mobility Assessment balance part; BLS, Burke Lateroplusion Scale.

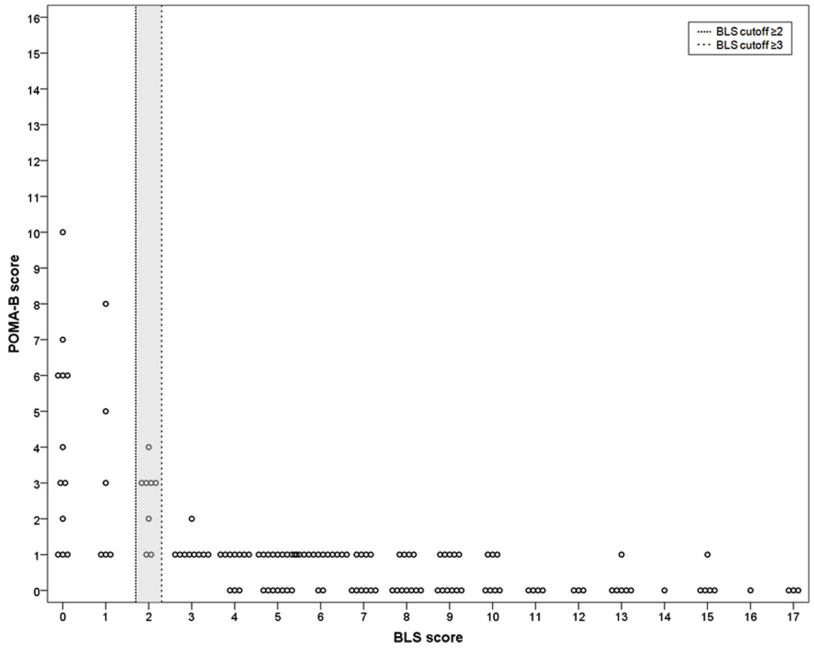

Fig. 2. Scatter plot showing the BLS scores and the POMA scores of all 137 data points. The gray area marks data sets with a BLS score of 2, which just resulted in the classification of PB when using the original cutoff.
POMA-B, Performed Oriented Mobility Assessment balance part; BLS, Burke Lateroplusion Scale.

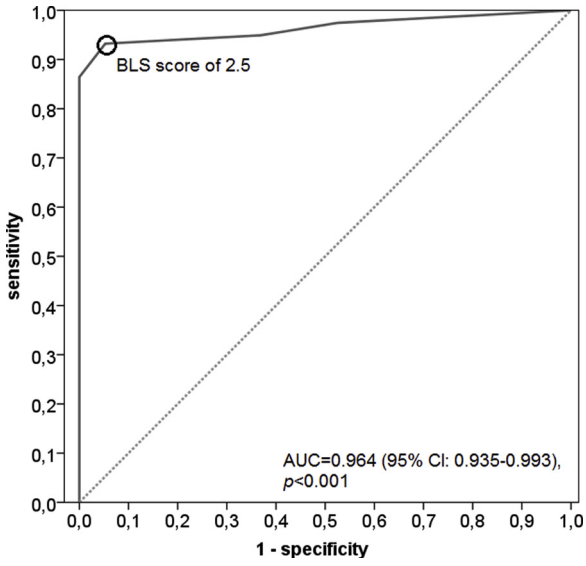

Fig. 3. Receiver Operating Characteristic curve showing the sensitivity and false positive rate (1-specificity) of the BLS to identify severe balance impairments during standing and posture transitions. The circle marks the cutoff point with the maximum Youden Index.
AUC, Area under the Curve; BLS, Burke Lateropulsion Scale.

per component [12]) in the classification of PB when an altered BLS cutoff of ≥3 instead of ≥2 was used [6]. Moreover, a BLS score ≥3 shows agreement with an impaired inner reference of verticality [1]. The BLS score positively correlates with an ipsilesional deviation of the SPV during standing. Though, in patients with a BLS score of 2, the SPV is within the ranges of normality, i.e. they show no abnormal verticality perception in the frontal plane [1].

Assuming that PB represents a spectrum of severity (which is also reflected in the scoring of the BLS [11]), the need for cutoff scores has to be discussed. However, in particular for research purposes and intervention planning, it seems important to differentiate between PB, which is associated with an impaired inner reference of verticality and a dramatic postural impairment, and milder forms of lateropulsion, which mainly hinder weight shifting to the non-paretic side during standing and/or walking. Nonetheless, it has to be considered that patients with a BLS score of 1 or 2 still show serious balance impairments which need to be addressed by specific treatment. While patients with a BLS score ≥3 might profit from an intervention focusing on the recalibration of the inner reference of verticality [13], training of adequate weight shift to the non-paretic body side during high-level tasks might be helpful for patients with BLS scores of 1 or 2.

The results of this study revealed a further distinguishing point: a BLS scores ≥11 was associated in all but two cases with POMA-B scores of 0. This indicates that patients with a BLS score ≥11 show severe PB which considerably hinders a safe sitting position. A previous study used a BLS score of ≥13 to categorize severe PB, but the authors did not give a rationale for this value [10]. However, even if there is a relationship between PB assessed with the BLS and balance performance measured with the POMA-B, it has to be considered that the two scales measure different constructs.

Our results implicate a reinterpretation of previous studies published with a BLS cutoff ≥2. To the best of our knowledge, it concerns three studies that investigated the rehabilitation outcome and impairments associated with the recovery of PB [14–16]. Most studies so far published used the SCP as this was long time the most frequently employed clinical scale. The SCP (cutoff > 0 per component) shows high agreement with the BLS cutoff ≥3 [6], consequently, we expect not much change in the results of these studies. However, since the BLS was recently recommended as the preferred tool to evaluate PB [5], we anticipate an increasing number of studies using the BLS within the next few years. The use of a more valid cutoff score will render the research more relevant and clinically meaningful. Nevertheless, further effort is required to establish a gold standard which allows to consistently quantifying the severity and presence of PB.

One significant limitation of the study is the variable number of repeated measures included in the ROC analysis which might have skewed the results. Repeated measures were done to track the recovery of PB and balance performance. Additionally, the POMA-B showed floor effects in our study population. Future studies should use scales which include more low-level tasks.

Based on the findings of the present and previous studies, we suggest changing the BLS cutoff to ≥3 to diagnose PB for research purposes and intervention planning. A cutoff ≥3 instead of ≥2 (1) leads to better agreement with the classification of the SCP [6], and (2) correlates with impaired verticality perception [1] and (3) with severe balance impairments during standing and postural transitions. Additional studies are needed to further evaluate the clinical value of a cutoff score ≥3.

Declarations of interest

None.

Conflict of interest statement

The authors declare that they have no conflict of interest.

Acknowledgments

The authors thank Katie Göttlinger for copyediting the manuscript. The work was supported by funds from the German Federal Ministry of Education and Research (BMBF IFB 01EO0901). The funding source did not have any involvement in the planning and execution of the study.

References

[1] J. Bergmann, C. Krewer, C. Selge, F. Müller, K. Jahn, The subjective postural vertical determined in patients with pusher behavior during standing, Top. Stroke Rehabil. 23 (2016) 184–190.
[2] H.O. Karnath, S. Ferber, J. Dichgans, The origin of contraversive pushing: evidence for a second graviceptive system in humans, Neurology 55 (2000) 1298–1304.
[3] D.A. Pérennou, G. Mazibrada, V. Chauvineau, R. Greenwood, J. Rothwell, M.A. Gresty, et al., Lateropulsion, pushing and verticality perception in hemisphere stroke: a causal relationship? Brain 131 (2008) 2401–2413.
[4] P.M. Davies, Steps to Follow: a Guide to the Treatment of Adult Hemiplegia, Springer, New York, 1985.
[5] R. Koter, S. Regan, C. Clark, V. Huang, M. Mosley, E. Wyant, et al., Clinical outcome measures for lateropulsion poststroke: an updated systematic review, J. Neurol. Phys. Ther. 41 (2017) 145–155.
[6] J. Bergmann, C. Krewer, K. Riess, F. Müller, E. Koenig, K. Jahn, Inconsistent classification of pusher behaviour in stroke patients: a direct comparison of the Scale forContraversive Pushing and the Burke Lateropulsion Scale, Clin. Rehabil. 28 (2014) 696–703.
[7] M.A. D'Aquila, T. Smith, D. Organ, S. Lichtman, M. Reding, Validation of a lateropulsion scale for patients recovering from stroke, Clin. Rehabil. 18 (2004) 102–109.
[8] M.E. Tinetti, Performance-oriented assessment of mobility problems in elderly patients, J. Am. Geriatr. Soc. 34 (1986) 119–126.
[9] J. Canbek, G. Fulk, L. Nof, J. Echternach, Test-retest reliability and construct validity of the tinetti performance-oriented mobility assessment in people with stroke, J. Neurol. Phys. Ther. 37 (2013) 14–19.
[10] E. Clark, K.D. Hill, T.D. Punt, Responsiveness of 2 scales to evaluate lateropulsion or pusher syndrome recovery after stroke, Arch. Phys. Med. Rehabil. 93 (2012) 149–155.
[11] S.R. Babyar, M.G. Peterson, R. Bohannon, D. Pérennou, M. Reding, Clinical examination tools for lateropulsion or pusher syndrome following stroke: a systematic review of the literature, Clin. Rehabil. 23 (2009) 639–650.
[12] M. Baccini, M. Paci, L. Nannetti, C. Biricolti, L.A. Rinaldi, Scale for Contraversive Pushing: cutoff scores for diagnosing "pusher behavior" and construct validity, Phys. Ther. 88 (2008) 947–955.
[13] D. Pérennou, C. Piscicelli, G. Barbieri, M. Jaeger, A. Marquer, J. Barra, Measuring verticality perception after stroke: why and how? Neurophysiol. Clin. 44 (2014) 25–32.
[14] S.R. Babyar, M.G. Peterson, M. Reding, Case-control study of impairments associated with recovery from "pusher syndrome" after stroke: logistic regression analyses, J. Stroke Cerebrovasc. Dis. 26 (2017) 25–33.
[15] S.R. Babyar, M.G. Peterson, M. Reding, Time to recovery from lateropulsion dependent on key stroke deficits: a retrospective analysis, Neurorehabil. Neural Repair 29 (2015) 207–213.
[16] S.R. Babyar, H. White, N. Shafi, M. Reding, Outcomes with stroke and lateropulsion: a case-matched controlled study, Neurorehabil. Neural Repair 22 (2008) 415–423.