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Validation of a lateropulsion scale for patients recovering from stroke

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Objective: To determine the validity and reliability of a clinical scale for assessing lateropulsion following stroke.

Design: Serial observational study of Lateropulsion Scale scores.

Setting: Inpatient stroke rehabilitation unit.

Subjects: A convenience sample of 85 patients examined 19 ± 2 SEM days post stroke.

Main outcome measures: An empirically derived 17-point Lateropulsion Scale was used to assess and follow postural responses to rolling, sitting, standing, transferring and walking. Intraclass correlation coefficients were calculated by having patients evaluated twice by their primary physical therapist (days 1 and 3), and once by an alternate physical therapist (day 2). Concurrent validity was estimated by computing Spearman’s rank order correlations between the lateropulsion score and other markers for motor control dysfunction: Fugl-Meyer balance subscore, the Functional Independence Measure (FIM) mobility subscore, and length of rehabilitation hospital stay.

Results: Inter-rater and intra-rater reliability were $r = 0.93$ ($p < 0.001$) and $r = 0.94$ ($p < 0.05$), respectively. Concurrent validity estimates showed the initial lateropulsion score to be correlated with the Fugl-Meyer balance subscore ($r = -0.57$, $p < 0.001$), with the admission and discharge FIM mobility subscores ($r = -0.56$, $p < 0.0001$ and $r = -0.58$, $p < 0.0001$), respectively, and with length of rehabilitation hospital stay ($r = 0.6$, $p < 0.0001$).

Conclusions: The Lateropulsion Scale is both a reliable and a valid assessment of lateropulsion following stroke.

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Introduction

PM Davies gave one of the first descriptions of lateropulsion in 1985. She described it as follows: ‘the patient pushes strongly towards their hemiplegic side in all positions and resists any attempt at passive correction of their posture, that is, correction which would bring their weight towards or over the mid-line of the body to the unaffected side.’ Such patients report the impression of lateral instability and fear of falling towards their uninvolved side. They have no awareness that their active pushing towards the side of hemiparesis is counterproductive, making it impossible for the patient to stand without assistance. Davies noted that lateropulsion was often associated with spatial neglect and anosognosia and that it was most commonly seen following right hemispheric injury. This phenomenon has also been called ‘listing phenomenon’, and ‘pusher syndrome’. All three terms are synonymous, and for the sake of simplicity will be referred to as lateropulsion.

Lateropulsion reflects an altered perception of the body’s orientation with respect to gravity. Patients with lateropulsion believe that their body is upright when it may actually be tilted up to 30 degrees towards the paretic side. Patients use their uninvolved extremities to actively resist attempts to restore them to true vertical posture. Lateropulsion may also affect body orientation when supine. Patients may resist rolling towards their intact side.

Pedersen et al. investigated some of Davies’ observations. They confirmed the existence of lateropulsion, but found no significant association with side or location of stroke, hemispatial neglect, hemisensory deficit, or anosognosia. This seeming contradiction is explained by more recent studies which indicate that perception of body verticality is controlled by multimodal input from visual, somatosensory and vestibular afferents. Loss of one or more of these sensory systems may be compensated by those that are unaffected. This implies that the severity and rate of recovery of lateropulsion may be dependent upon the number of sensory control systems affected.

Lateropulsion prolongs recovery following stroke. Pedersen et al. found that improvement in ADL scores plateaued by 13 weeks in patients without lateropulsion, but not until 19 weeks in those with lateropulsion. Patients with lateropulsion also had more severe strokes with worse initial neurological stroke severity scores than those without. Those with lateropulsion had worse activities of daily living (ADL) scores for dressing, transferring from bed to wheelchair, wheelchair mobility and walking. Lateropulsion was also associated with an increased risk of falling.

We are not aware of any published standardized scales to identify and score lateropulsion. Such a scale would help define the natural history, neuroanatomic correlates, and treatment responsiveness of this important but poorly defined phenomenon. We therefore decided to formally assess the validity of an empirically derived Lateropulsion Scale which was used at our institution. The scale was first developed in 1993, and was revised several times over the ensuing years by the physical therapy team on our inpatient stroke rehabilitation unit.

Methods

All subjects were residents on an inpatient stroke rehabilitation unit at Burke Rehabilitation Hospital. The diagnosis of stroke was as defined by WHO criteria and confirmed by neuroimaging studies in each case. Lateropulsion scoring is incorporated in our standardized stroke admission assessment. The only variable introduced as part of this study protocol was evaluation by a second observer, on day 2, to measure inter-rater variability on the Lateropulsion Scale. Subjects selected were a convenience sample of patients who were medically stable and deemed appropriate for inpatient stroke rehabilitation. Patients with orthostatic hypotension, agitation, excessive somnolence, or previous orthopaedic problems which might interfere with assessment of posture and balance were excluded. Patients who refused to participate in testing were excluded.

Neurologic and neuroimaging data were available for each patient as part of a computerized stroke admission data bank. Hemispatial visual neglect or other hemifield visual deficits were scored by confrontation visual field testing.
admission. Spearman’s rank order correlation coefficient was chosen as the statistic most appropriate for comparison of both scales, which are nonparametric. Spearman’s correlations were also used to explore relationships between Lateropulsion Scale scores and other clinical variables of interest: admission FIM mobility subscore, length of rehabilitation hospital stay, and discharge FIM mobility subscores. The nonparametric Mann–Whitney U statistic was used to assess change in scores from day 1 to day 2 and from day 1 to day 3, and to compare Lateropulsion Scale scores for those with right versus left hemisphere stroke.

Results

Eighty-five (50 females, 35 males) of the 90 subjects recruited for the study completed the three required Lateropulsion Scale evaluations. Five subjects were dropped from the study secondary to being medically unstable and unable to complete the required evaluations within the specified seven-day time frame. None of the subjects experienced any complications, as a result of their participation in the study.

The mean interval from stroke to study evaluation was 19 ± 2 SEM days. Stroke location was as follows: right hemisphere 35, left hemisphere 33, bilateral hemisphere 4, brainstem-cerebellum or other combination of locations 15. Visual field deficits were as follows: left hemianopsia or visual neglect 18, right hemianopsia or visual neglect 11, normal visual fields 56. The mean lateropulsion score for patients with right hemisphere stroke was 1.7 ± 1.7 SD versus 2.1 ± 3 SD for those with left hemisphere stroke (\(p = 0.65\), Mann–Whitney U statistic). The frequency of lateropulsion scores greater than 0 was similar for patients with right (16/35) and left (15/33) hemisphere stroke.

In order to assess inter-rater reliability, the intraclass correlation coefficient was computed for lateropulsion scores obtained by the patient’s primary therapist on day 1 and from the study therapist on day 2. The inter-rater correlation was 0.93, \(p < 0.001\). Scores for day 1 versus day 2 were as follows: 1.96 ± 3.26 SD and 1.71 ± 2.94 SD. The difference in scores for the two independent raters was not statistically significant.
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(Mann–Whitney U statistic, \( p = 0.80 \)). A bivariate scattergram of the sores for the two observers on day 1 versus day 2 is shown in Figure 1.

In order to assess intra-rater reliability, the intraclass correlation coefficient was computed for lateropulsion scores obtained from the patient’s primary therapist on days one and three. The intra-rater correlation was \( 0.94, p < 0.05 \). Scores for day 1 versus day three were as follows: \( 1.96 \pm 3.26 \) SD and \( 1.58 \pm 2.98 \) SD. The difference in scores for the same rater two days apart was not statistically significant (Mann–Whitney U statistic, \( p = 0.78 \)).

Concurrent validity was assessed using Spearman’s rank order correlation coefficient comparing lateropulsion scores on day 1 to the balance subscore of the admission Fugl-Meyer Assessment Scale (FMA). The balance subscore of the FMA assesses sitting and standing balance, but does not directly assess lateropulsion.\(^8\) The correlation between these two measures was \(-0.57, p < 0.001\). See Figure 2 for a bivariate scattergram showing the relationship between lateropulsion scores for day 1 versus admission Fugl-Meyer balance scores. Concurrent validation is further supported by Spearman’s rank order correlations comparing lateropulsion scores with other markers for severity of functional disability: admission FIM mobility subscores \( (r = -0.56, p < 0.0001) \), discharge FIM mobility subscore \( (r = -0.58, p < 0.0001) \), and length of rehabilitation hospital stay \( (r = 0.60, p < 0.0001) \).

The content validity of the Lateropulsion Scale is supported by its evolution through multiple versions over an eight-year period of use on an inpatient stroke rehabilitation unit. The original version of the Lateropulsion Scale (1993) included the following test positions: supine, sitting and standing, with a score of 0–3 for each position. Based on feedback from physical therapy team members using the Lateropulsion Scale it evolved through three revisions. The final version also contains these test positions, but provides for weighting of scores for features thought to be most characteristic of lateropulsion. Weights were assigned based on the consensus opinion of the therapy team responsible for scale development. Additional test positions were added to allow for assessment of lateropulsion during more dynamic activities such as transferring and walking (see Appendix).

![Figure 1](image_url) Bivariate scattergram of lateropulsion scores obtained by the patient’s primary therapist on day 1 versus lateropulsion scores by the study therapist on day 2.
Discussion

The aim of this study was to determine the reliability and validity of a clinical scale to quantify the severity of lateropulsion following stroke. The inter-rater and intra-rater reliability coefficients observed (0.93, \( p < 0.001 \) and 0.94, \( p < 0.05 \) respectively) support the conclusion that the Lateropulsion Scale is indeed reliable. The concurrent validity of the Lateropulsion Scale is supported by its correlation coefficient of -0.57, \( p < 0.001 \) with the balance subscale of the Fugl-Meyer Assessment. Use of the FMA (which does not specifically assess lateropulsion) as a surrogate criterion standard was considered appropriate, since there were no more specific standardized scales available. The content validity of the Lateropulsion Scale is supported by its evolution over eight years, with successive versions modified based on the experience and suggestions of multiple physical therapists.

The large standard deviations observed for lateropulsion scores on days 1, 2 and 3 reflect the spectrum of lateropulsion severity observed in our patient sample. Scores ranged from 0 (no lateropulsion) to 17 (maximal lateropulsion). The large standard deviations are a necessary result of evaluating patients expressing the full spectrum of lateropulsion severity. The high inter-rater and intra-rater correlations observed across the full spectrum of possible lateropulsion scores further support the clinical utility of the Lateropulsion Scale.

Comparison of the mean lateropulsion scores recorded on days 1, 2 and 3 shows a nonsignificant trend towards improvement in scores over time: 1.96, 1.71 and 1.58, respectively. Improvement in the mean values could be attributed to improvement in the therapist’s handling skills with the therapist becoming more familiar with

Clinical messages

- The Lateropulsion Scale is valid and reliable.
- It correlates with other measures of functional disability.
- It can be used to define the natural history, treatment response and neuroanatomic correlates of lateropulsion following stroke.
the unique responses of each patient, to increased patient confidence with repeated testing, or to improvement in the lateropulsion phenomenon being scored. Since improvement in scores was seen across examiners (day 1 versus day 2), the improvements noted are probably not examiner-dependent. One could argue that the steady improvement in scores over the three days of observation indicates a problem with scale reliability. This seems unlikely as unreliability would be reflected by increased score variance and lower inter-rater and intra-rater intraclass correlation coefficients. Our experience indicates that the observed reliability statistics are comparable to other accepted clinical assessment scales. Since other investigators have also noted practice–dependent improvement in lateropulsion, it seems reasonable to suggest that the improvements noted reflect change in performance. If this is true, then the lateropulsion scale is not only reliable, and valid, but also sensitive to subtle change in performance.

The weaknesses of the Lateropulsion Scale are those of many clinical scales. It is composed of ordinal measures, which are summed to derive a composite score. The assessments are subjective and can be affected by both patient and therapist comfort and familiarity with the test protocol. The scale is based on empirical observations that lateropulsion in its most severe form is expressed in all body orientations: supine, sitting, standing, walking. In its least severe presentation it may be present only with high-level dynamic activities such as walking. More detailed longitudinal studies of lateropulsion may disprove these assumptions.

Lateropulsion scores were not significantly different for patients with right versus left hemisphere stroke. This is consistent with prospective data presented by Pedersen et al.2 It is also consistent with prospectively collected data reported by the current authors.10 Postural control is thought to be mediated by visual, somatosensory, and vestibular afferents. Patients can learn to compensate for loss of one or more of these afferent systems by relying on those that remain. The clinical impression that lateropulsion is most commonly associated with right hemisphere stroke may be due to the specialization of the right hemisphere for processing multimodal visual, somatosensory and auditory attention. Damage to the right parietal lobe may significantly delay or limit a person’s ability to use compensatory strategies for regaining postural control. If this is true, then prospective studies of lateropulsion early in recovery might fail to show the right hemisphere predominance noted in cross-sectional studies performed 2–3 months post stroke. Assessments in the current study were performed prospectively a mean of 19 ± 2 SEM days post stroke.

The Lateropulsion Scale allows lateropulsion to be objectively identified and graded following stroke. It has been used by the authors in a neuroimaging study to identify the neuroanatomic correlates of lateropulsion.10 Its prospective use may help define the frequency and natural history of lateropulsion following stroke. It should also allow the effects of alternative treatment strategies on recovery to be tested.

In summary, the data presented show the Lateropulsion Scale to be valid and reliable. This scale provides an objective assessment of the severity of lateropulsion and can be used to study its natural history, neuroanatomic correlates and response to treatment intervention.10

References

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Appendix – Lateropulsion Scale

Supine
Use ‘log roll’ technique to test patient’s response. Roll first towards the affected side then towards the unaffected side. Circle the side to which the resistance is most prominent. Score below the maximum resistance felt and add one point if resistance is noted in both directions. (Patients with marked lateropulsion may resist rolling to either side, hence an extra point is added if resistance is noted with rolling both towards and away from the affected side).

0 = No resistance to passive rolling
1 = Mild resistance
2 = Moderate resistance
3 = Strong resistance
4 = Add one point if resistance noted in both directions

Sitting
Score with the patient seated, feet off floor, with both hands in lap. The expected hemiplegic response is for patient to carry his weight towards the unaffected side. Some patients will passively fall towards their paretic side when placed in true vertical position by the examiner. This will not be scored as ‘lateropulsion’. Position the patient with their trunk 30 degrees off true vertical towards their affected side, then score the patient’s response to your attempts to bring them back to vertical. The ‘lateropulsion’ phenomenon is an active attempt by the patient to keep their centre of gravity towards their impaired side as they are brought to true vertical.

0 = No resistance to passive return to true vertical sitting position
1 = Voluntary or reflex resistive movements in trunk, arms or legs noted only in the last five degrees approaching vertical.
2 = Resistive movements noted but beginning within 5 to 10 degrees of vertical
3 = Resistive movements noted more than 10 degrees off vertical

Standing
Score with the patient standing with whatever support is needed. The expected hemiplegic response is for the patient to carry their weight toward the unaffected side or to passively fall towards their paretic side when placed in true vertical position by the examiner. This will not be scored as ‘lateropulsion.’ Position the patient with their trunk 15 to 20 degrees off true vertical towards their affected side then score the patient’s response to your attempts to bring them back to vertical, then 5 to 10 degrees past vertical toward the intact side. The ‘lateropulsion’ phenomenon is a voluntary or reflexive response in the trunk or limbs to keep the centre of gravity towards the impaired side e.g., forced trunk curvature towards the paretic side, flexion of affected hip or knee, shifting weight to the lateral aspect of the unaffected foot.

0 = Patient prefers to place his centre of gravity over the unaffected leg.
1 = Resistance is noted when attempting to bring the patient 5 to 10 degrees past midline.
2 = Resistive voluntary or reflex equilibrium responses noted, but only within 5 degrees of approaching vertical.
3 = Resistive reflex equilibrium responses noted, beginning 5 to 10 degrees off vertical.
4 = Resistive voluntary or reflex equilibrium responses noted, more than 10 degrees off vertical.
Transfers
Score this function by transferring the patient from the seated position first to the unaffected side, then if possible, to the affected side. The expected hemiplegic response would be for the patient to require more assistance to transfer towards the affected side (use a sit pivot, modified stand pivot, or stand pivot transfer, depending on the patient’s functional level).

0 = No resistance to transferring to the unaffected side is noted.
1 = Mild resistance to transferring to the unaffected side.
2 = Moderate resistance to transferring is noted. Only one person is required to perform the transfer.
3 = Significant resistance is noted with transferring to the unaffected side. Two or more people are required to transfer the patient due to the severity of lateropulsion.

Walking
Score lateropulsion by noting active resistance by the patient to efforts by the therapist to support the patient in true vertical position. Do not score passive falling or leaning to the paretic side. Score lateropulsion as follows:

0 = No lateropulsion noted.
1 = Mild lateropulsion noted.
2 = Moderate lateropulsion noted with walking.
3 = Strong lateropulsion noted, takes two individuals to walk with the patient, or unable to walk because of severity of lateropulsion.

Circle most prominent direction of lateropulsion: left, right, posterior-left, posterior-right.

Note: Some patients may show such marked lateropulsion that they can not be assessed while standing or walking. In such cases they are scored as having a maximum deficit for those tasks not testable due to the severity of their lateropulsion.

TOTAL SCORE = SUM OF THE ABOVE _____ (Max = 17)