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TEMPORAL ASSOCIATIONS OF LATEROPULSION RESOLUTION AND BALANCE RECOVERY AFTER HEMISPHERIC STROKES

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Disorder of body orientation with respect to gravity is one of the key elements that impairs balance control in post-stroke patients. We investigated the temporal associations between the normalization of body orientation in the frontal plane and balance recovery after hemispheric strokes. We included in the study patients with hemispheric strokes occurring within the last month. 53 patients had lateropulsion and 7 patients had pusher syndrome, according to the Scale for Contraversive Pushing. Patients were subsequently invited for a weekly examination until the body's verticality was normalized. At each visit, the balance status was assessed. Recovery of balance control depended on the normalization of body orientation in the frontal plane. Recovery of the sitting and standing balance was maximal during the weeks of transition of pusher syndrome into lateropulsion and during the weeks of resolution of lateropulsion into uprightness.

Key words: hemispheric stroke, lateropulsion, pusher syndrome, balance, recovery.

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ЧАСОВІ АСОЦІАЦІЇ МІЖ РОЗРІШЕННЯМ ФЕНОМЕНУ ЛАТЕРОПУЛЬСІЇ ТА ВІДНОВЛЕННЯМ БАЛАНСУ ПІСЛЯ ГЕМІСФЕРАЛЬНИХ ІНСУЛЬТІВ

Порушення орієнтації тіла відносно вектору сили тяжіння є одним з елементів, що погіршує баланс тіла у постінсультних пацієнтів. Ми дослідили часові асоціації між відновленням орієнтації тіла у фронтальній площині та покращенням сидячого і стоячого балансу після інсульту. У дослідження були включені пацієнти з гемісферальними інсультами, що виникли протягом останнього місяця. У 53 пацієнтів було діагностовано латеропульсію та у 7 пацієнтів – синдром відштовхування, згідно шкали Scale for Contraversive Pushing. Після первинного обстеження пацієнти запрошувалися на щотижневі огляди до моменту нормалізації вертикального положення тіла. Під час кожного візиту оцінювався стан сидячого та стоячого балансу. Покращення показників усіх шкал балансу прямо залежало від часових особливостей нормалізації орієнтації тіла у фронтальній площині. Більше того, відновлення показників балансу було максимальним саме протягом міжвізитних тижневих періодів трансформації синдрому відштовхування в латеропульсію та протягом міжвізитних тижневих періодів розрешення латеропульсії.

Ключові слова: гемісферальні інсульти, латеропульсія, синдром відштовхування, баланс, відновлення.

The study is a fragment of the research project "Optimization of diagnosis, prognosis and prevention of neuropsychological disorders in organic diseases of the nervous system", state registration No. 0120U104165.

Optimizing rehabilitation strategies for a range of illnesses is necessary due to the military actions in Ukraine that resulted in the destruction of healthcare facilities and interrupted healthcare delivery [8].

One of the leading problems of modern stroke medicine is the problem of post-stroke rehabilitation. Understanding the recovery patterns following a stroke can help choose the best course of action and when to begin rehabilitation. Human body balance is the capacity to regulate posture during functional activities to keep an upright stance and to compensate internal and external body disturbances to prevent falls. The complex system of post-stroke balance impairments includes motor, sensory, vestibular, cerebellar and cognitive elements that interact with the environment and one another [7]. Lateropulsion is a faulty internal verticality model that tilts the side opposing the hemisphere strokes, which is a deficit of the active body orientation with regard to gravity in the frontal plane [5]. At present lateropulsion is considered a result of a disruption of the brain network responsible for perceiving body verticality [14]. Lateropulsion is one of the key elements that impairs static and dynamic balance control in patients with hemispheric strokes [1]. According to present knowledge, lateropulsion is considered a continuum between light form – lateropulsion itself and severe form – pusher syndrome (PS) that includes lateral body tilt, active pushing from sound limbs to initiate or amplify the body tilt, and resistance to posture correction. [3].

Even mild forms of lateropulsion have a detrimental effect on balance and gait capacities in subacute hemispheric stroke [4]. Furthermore, in a retrospective study post-stroke lateropulsion was linked to a longer rehabilitation period, a lower functional recovery, and reduced likelihood of discharge home from inpatient rehabilitation, regardless of stroke-related disability [10].

Thus, it can be assumed that the process of balance recovery after a stroke also depends on the temporal peculiarities of normalization of body orientation with respect to gravity. However, up to date, no prospective studies have been conducted to investigate the temporal characteristics of balance recovery depending on the resolution of PS and lateropulsion in patients with hemispheric stroke.

The purpose of the study was to investigate in the longitudinal study the temporal associations between normalization of body orientation in the frontal plane and balance recovery after hemispheric strokes.

Materials and methods. This study was approved by the Ethics Committee of Poltava State Medical University, in accordance with the Declaration of Helsinki (protocol No. 189/2020). Written informed consent was obtained for all patients before their inclusion in the study.

Criteria for inclusion of patients in the study:

- hemispheric strokes occurring within the last month;
- the presence of lateropulsion or PS at the first examination;
- written patient consent.

Criteria for exclusion of patients from the study:

- visual, vestibular, and proprioceptive disorders that distort the verticality perception;
- orthopedic and other neurological pathology that led to passive or active changes in the body axis;
- decompensated somatic pathology;
- psychiatric and narcological pathology;
- use of drugs that disturb postural balance (anticonvulsants, sedatives, tranquilizers, neuroleptics, tricyclic antidepressants);
- impaired writing function, which does not allow for proper completion of the questionnaires.

Lateropulsion and PS were diagnosed using the Scale for Contraversive Pushing (SCP). The SCP assesses three different factors when an individual is sitting or standing: the tilt of the body axis in the frontal plane, active pushing with unaffected limbs in the opposite direction, and active resistance during posture correction. The overall SCP score ranged from 0 to 6. Lateropulsion has been identified when there is an isolated body tilt in a sitting or standing position without pushing or resistance – that is when the SCP value is ≥ 0.5 . PS was diagnosed with a total score of SCP ≥ 3 [5].

The balance was assessed using Berg Balance Scale (BBS), Postural Assessment Scale for Stroke (PASS), Trunk Impairment Scale (TIS) and Timed Up and Go Test (TUG).

The BBS measures static and dynamic balance. It is composed of 14 tasks, graded on a 5-point scale for a total of 56, that require the participant to perform various balance tasks.

PASS assesses static and dynamic balance abilities in daily life, the PASS total score ranging from 0 to 36.

TIS is used to evaluate sitting balance and trunk control. The TIS comprises three subscales that assess static sitting balance, dynamic sitting balance, and trunk coordination generating a total score between 0 and 23.

TUG test is used to assess the dynamic balance and gait maneuvers used in daily activities; TUG test results are measured in seconds.

Patients were asked for weekly examinations after being included in the study, and this process continued until uprightness was restored. Balance status was assessed at each visit by means of BBS, TIS, PASS and TUG test.

Data were presented as median with the interquartile range. Balance data changes between the initial examinations and the visits when uprightness was already restored were analyzed using the Wilcoxon signed-rank test for paired samples. For analyzing the dynamics of balance values depending on changes in PS (lateropulsion), the data scores of BBS, PASS, and TIS were converted into percentages of the maximum scores. We calculated the percentage changes in each of the scales between two consecutive weekly examinations with no change in body orientation and between two subsequent weekly examinations when at the last examination PS transformed into lateropulsion or lateropulsion resolved. The TUG test values, depending on changes in body axis orientation, were analyzed in absolute units (seconds). A comparison of changes in balance values as a function of uprightness status were performed by the Mann-Whitney test for unpaired data. A p-value < 0.05 was considered statistically significant.

Results of the study and their discussion. A total of 70 patients were recruited in the study, of whom 61 were diagnosed with lateropulsion and 9 with PS. During the study, 10 patients (8 with lateropulsion and 2 with PS) for various reasons (refusal of repeated examinations, death, change of residence) stopped participating in the study until uprightness was restored. Data on dropouts were excluded from the statistical analysis. Thus, 53 patients with lateropulsion and 7 patients with PS were included in the analysis.

The median age of patients with lateropulsion was 67.0 (57.0–73.0) years and the median age of patients with PS was 61.0 (53.0–75.0) years. The lateropulsion group consisted of 30 males and 23 females, whereas the PS group consisted of 3 males and 4 females. Hemorrhagic strokes occurred in 2 patients with lateropulsion and 3 patients with PS, ischemic stroke occurred in 51 patients with lateropulsion and 4 patients with PS. The right cerebral hemisphere was affected in 40 patients with lateropulsion and 5 patients

with PS. The median time of resolution of lateropulsion was 6.0 (5.0–6.0) weeks and the median time of resolution of PS was 8.0 (6.8–10.3) weeks.

Table 1 presents the data on balance recovery between the values at initial visits and values at the final visits when PS (or lateropulsion).

Table 1

Changes of balance measures in patients with disorders of body orientation in the frontal plane

Patients group	Visits	The measure of balance			
		BBS, points	PASS, points	TIS, points	TUG test, seconds
PS	initial	25 (21–27)	12 (11–15)	0 (0–14)	–
	final	47 (37–49) *	28 (26–32) *	19 (16–20) *	23 (23–25) *
lateropulsion	initial	40 (37–43)	24 (20–25)	16 (15–18)	27 (25–30)
	final	51 (49–52) *	32 (28–33) *	19 (17–20) *	19 (17–23) *

Notes: significant differences ($p < 0.05$), according to the Wilcoxon test, in comparison with initial examination values.

As can be seen from Table 1, in patients with PS and lateropulsion at the first visits after restoring their upright body position, the results of BBS, PASS, TIS, and TUG test were significantly improved compared to initial values. These findings could indirectly suggest that restoring of body uprightness in patients after hemispheric strokes has a beneficial impact on sitting and standing balance performance. However, in post-stroke patients the control of balance depends, besides disorders of body orientation in the frontal plane, on many other components. So, the demonstrated phenomenon of balance improvement may be a consequence of the improvements of many another balance element (muscle strength, proprioception, cerebellar and vestibular ataxias, basal ganglia functions, spatial hemineglect, cognition, so on).

So, the next step was to analyze in detail how the recovery changes of body orientation in the frontal plan (or lack thereof) were associated with the changes in BBS, PASS, and TIS scores. For this purpose, we compared changes in the median percentages of the maximum scores of BBS, PASS and TIS between two consecutive weekly visits as a function of changes in body orientation. Results of this comparison are demonstrated in Table 2.

Table 2

Median (interquartile range) changes of scales between the different weekly visits expressed in percentage of the maximum scores

Body orientation at two consecutive weekly visits	The measure of balance		
	BBS, %	PASS, %	TIS, %
PS – PS	8.9 (7.1–10.7)	11.1 (8.3–22.8)	17.4 (0.0–17.4)
PS – lateropulsion	17.9 (14.0–25.0) *	30.6 (22.2–36.1) *	52.2 (21.7–69.6) *
lateropulsion – lateropulsion	7.1 (5.4–10.7)	8.3 (2.8–13.9)	4.3 (0.0–8.7)
lateropulsion – uprightness	10.7 (7.1–13.4) ** ***	13.9 (8.3–19.4) ** ***	8.7 (2.2–13.0) ** ***

Notes: * significant differences ($p < 0.05$), according to the Mann-Whitney test, in comparison with results of two consecutive weekly visits “PS – PS”. ** significant differences ($p < 0.05$), according to the Mann-Whitney test, in comparison with results of two consecutive weekly visits «lateropulsion – lateropulsion». *** significant differences ($p < 0.05$), according to the Mann-Whitney test, in comparison with results of two consecutive weekly visits “PS – lateropulsion”.

Table 2 demonstrates certain regularities in changes in the median percentage of the maximum scores depending on the changes in the body orientation in the frontal plane. The median percentage of improvement in the values of BBS, PASS and TIS was significantly higher between weekly visits of transition of PS into lateropulsion (“PS – lateropulsion”) compared to the weeks of stable PS (“PS–PS”). A similar recovery pattern was also specific for the weeks of lateropulsion resolution – it was a reliable improvement in the median scores of BBS, PASS, and TIS during the weeks of resolution of lateropulsion (“lateropulsion – uprightness”) compared to the weeks of unchanged lateropulsion (“lateropulsion – lateropulsion”). Moreover, the median percentages improvements of all used scales were significantly higher during the weeks of transition of PS into lateropulsion (“PS – lateropulsion”) compared to the weeks of resolution of lateropulsion into uprightness (“lateropulsion – uprightness”). Thus, the more significant improvements in balance scores occurred exactly during the periods of the changes in body orientation in the frontal plane. Additionally, this pattern of balance recovery had its specific peculiarities: the weeks of transformation of PS into lateropulsion were associated with a more considerable optimization of BBS, PASS, and TIS scores than the weeks of resolution of lateropulsion into uprightness.

In addition, we also compared changes in the sitting and the standing balance as a function of the changes in body orientation in the frontal plane. For this purpose, we analyzed changes in the median percentages of the maximum scores of the scales representing standing balance (BBS, PASS) and the scale representing the sitting balance (TIS). During the weeks of unchanged PS (“PS – PS”), there were no significant differences in the changes in the median percentage of maximum scores of BBS, PASS, and TIS, due to the Mann-Whitney test. During the weeks of transformation of PS into lateropulsion (“PS –

lateropulsion”), the improvement of the median percentage of the maximum score of TIS was statistically higher (52.2 (21.7–69.6)) than the improvement of the median percentage of the maximum score of BBS (17.9 (14.0–25.0)), according to the Mann-Whitney test. Whereas, during the weeks of stable lateropulsion (“lateropulsion – lateropulsion”) as well as during the weeks of transformation of lateropulsion into uprightness (“lateropulsion – uprightness”) the improvement of the median percentage of the maximum scores of BBS and PASS were statistically higher than the improvement of the median percentage of the maximum score of TIS, due to the Mann-Whitney test. So, the time intervals of transformation of PS into lateropulsion were associated with a more intensive improvement in the sitting balance compared to the improvement in the standing balance. On the other hand, the time intervals of stable lateropulsion and the time intervals of resolution of lateropulsion were associated with a more intensive improvement in the standing balance compared to the sitting balance.

We examined the changes in TUG test values only in patients with lateropulsion because it was technically impossible to perform the TUG test in the majority of patients with PS. In addition, it is impossible to examine changes in test scores in percentages, since test results are expressed in absolute units. The median decrease in TUG test scores during the weeks of resolution of lateropulsion (“lateropulsion – uprightness”) was 5.0 (2.0–8.0) seconds, and this value was significantly greater ($p < 0.05$) than the median decrease in TUG test scores during the weeks of stable lateropulsion (“lateropulsion – lateropulsion”) – 2.0 (2.0–4.0) seconds, according to the Mann-Whitney test. So, the time intervals of resolution of lateropulsion were associated with a more pronounced recovery of the dynamic balance, compared with the time intervals of stable lateropulsion.

Our findings demonstrate that the improvement of body orientation with respect to gravity was associated with improvement of balance control. Especially important, the weeks during which body orientation improves (PS – lateropulsion) or normalizes (lateropulsion – uprightness) were matched with the highest degree of sitting and standing balance recovery. This phenomenon could be explained that stable body support and vertical body orientation are necessary for balance control. As known, postural balance is provided if the center of mass's projection on the ground is inside the base of support [9]. The projection of the center of mass on the ground in people who have deficiencies in body orientation moves away from the center of the base of support [13]. So, misorientation of the body axis concerning gravity leads to the limit of balance control as a function of the magnitude of the body tilt. Indeed, a recent paper has shown that lateropulsion is the most important factor explaining balance and gait disorders at the subacute stage after stroke [4].

Of interest is that the sitting balance improves relatively more intensively than the standing balance within the weeks of transformation of PS into lateropulsion, and the standing balance improves relatively more intensively within the weeks of resolution of lateropulsion. Sitting balance is provided predominantly by controlling the statics and dynamics of the trunk [2, 11]. Therefore, the pushing from the unaffected limbs and the resistance to correction of the body axis (the components of PS) seems to be a significant determinant of the sitting balance disorders. Standing balance is a more complex biomechanical phenomenon than sitting balance [6, 12]. So, the resolution of even minor deviations of the body axis (pure lateropulsion) could positively influence the standing balance. However, the regularities of the sitting and the standing balance recovery and the underlying processes require a separate specialized study.

To conclude, in this longitudinal cohort, our findings indicate that balance improvement is amplified during the weeks of recovery of body orientation in the frontal plane.

There are implications for clinical practice. Actively improving the status of body orientation concerning gravity in individuals with hemispheric stroke may have the potential to influence static and dynamic balance recovery. If the rate of recovery of body uprightness can be accelerated by rehabilitation means, that in turn may affect improving the rate of recovery of the balance.

Conclusion

Recovery of balance control after hemispheric strokes depends on the status of body orientation in the frontal plane. Enhancement in balance control is directly linked to an optimization in body orientation about gravity. Recovery of the balance is maximal during the weeks of transition of PS into lateropulsion and during the weeks of resolution of lateropulsion into uprightness. During the weeks of transformation of PS into lateropulsion, the sitting balance was recovering more intensely than the standing balance. During the weeks of stable lateropulsion and resolution of lateropulsion, the standing balance was recovering more intensely than the sitting balance. Rehabilitating a hemisphere stroke patient's body orientation concerning gravity may have an impact on the recovery of balance.

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ASSESSMENT OF QUALITY OF LIFE IN WOMEN WITH UNDIFFERENTIATED CONNECTIVE TISSUE DYSPLASIA

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To study the quality of women's life, based on developed clinical and laboratory criteria, for the period from 2019 to 2022, a prospective study of the course of pregnancy and its outcomes was conducted in 68 pregnant women aged 18 to 39 years (average age 27.98±5.3) with undifferentiated connective tissue dysplasia, which formed a high-risk group for the development of pathology of the fetoplacental system. The conducted studies found that the "physical component" and the "psychological component" of the quality of life in pregnant women are reduced equally, limiting household and social functioning. Possible ways to improve the quality of life of pregnant women were identified, affecting the reduced controllable characteristics of the state of health by means and methods of health improving physical culture.

Key words: quality of life, postpartum period, placental insufficiency, pregnancy

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ОЦІНКА ЯКОСТІ ЖИТТЯ У ЖІНОК ІЗ НЕДИФЕРЕНЦІЙОВАНОЮ ДИСПЛАЗІЄЮ СПОЛУЧНОЇ ТКАНИНИ

Для вивчення якості життя жінок, на підставі розроблених клініко-лабораторних критеріїв, за період з 2019 по 2022 рр., нами було проведено проспективне дослідження перебігу вагітності та її наслідків у 68 вагітних віком від 18 до 39 років (середній вік 27,98±5,3) із недиференційованою дисплазією сполучної тканини, які склали групи високого ризику щодо розвитку патології фетоплацентарної системи. Внаслідок проведених досліджень нами було встановлено, що «фізичний компонент» та «психологічний компонент» якості життя у вагітних жінок знижені рівною мірою, обмежуючи побутове та соціальне функціонування. Було визначено можливі способи підвищення рівня якості життя вагітних, що впливають на знижені керовані характеристики стану здоров'я засобами та методами оздоровчої фізичної культури.

Ключові слова: якість життя, післяпологовий період, плацентарна недостатність, вагітність

Pregnancy is a crisis period both in the life of a woman and the family as a whole [1]. During this period, it is necessary to provide the woman with a high quality of life. The success of a woman's adaptation to her pregnancy is influenced by her level of readiness for motherhood. According to some studies, modern young women are in a state of chronic stress [2, 3].