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ORIGINAL PAPER

Association between Falls and Balance among Inpatients with Schizophrenia: A Preliminary Prospective Cohort Study

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Abstract

Falls are adverse events affecting psychiatric inpatients that can lead to external injuries, fractures, and death. However, none have attempted to examine fall-related factors, particularly focused on balance, specifically among inpatients with schizophrenia. The present preliminary study aimed to assess the association between falls and balance in patients with schizophrenia. The authors performed baseline assessments of background factors, postural sway, and maximum step length in 120 patients with schizophrenia hospitalized in the psychiatric ward. A prospective 3-month follow-up was conducted, and participants were divided into a fall or non-fall group according to their history of falls during the follow-up. Variance among individual variables was compared between the fall group and non-fall group using the *t*-test, Mann–Whitney *U* test, and chi-square test. A total of 16 participants experienced falls in the 3-month follow-up period (13.3%). Comparative factor analysis revealed significant differences between the fall and non-fall groups in terms of the presence or absence of falls within 3 months before follow-up ($p = 0.002$) and Romberg quotients for sway length ($p = 0.02$). These findings suggest that fall history could be considered a predictor of future falls, which could help with fall prevention, and that assessment of visual contribution to postural control using the Romberg quotient could play an important role in fall prevention.

Keywords Fall · Risk · Schizophrenia · Inpatient

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Introduction

Falls are adverse events that affect psychiatric inpatients, which can lead to external injuries, fractures, and death, thereby posing a serious health issue [1, 2]. In a 34-month investigation conducted in the United States, Poster et al. [1] found that the rate of falls in a cohort of 4156 participants was 11.8%. Studies on falls in the psychiatric ward have examined a wide range of psychiatric disorders. Patients with schizophrenia are at a high risk for fractures because they exhibit elevated rates of osteoporosis and reduced bone mineral density when compared with the findings in the general population [3]. Previous studies have identified several risk factors for falls [2, 4, 5]. However, to our knowledge, almost no studies have attempted to examine fall-related factors specifically in patients with schizophrenia.

A previous study reported postural instability among patients with schizophrenia [6]. The study employed posturography to quantify postural instability and found that patients with schizophrenia demonstrated increased postural sway when compared with the findings in healthy individuals. Moreover, with regard to the influence of antipsychotics on postural sway, a large postural sway was observed among patients with schizophrenia, even after the exclusion of those who presented with the side effects of antipsychotics, indicating that there is no significant relationship between postural sway and antipsychotic dose [6, 7]. These findings suggest that patients with schizophrenia exhibit a large postural sway and are thus prone to falls.

Although inpatients with schizophrenia are at a high risk for falls and are highly vulnerable to fractures, almost no studies have analyzed fall-related risk factors or have investigated the circumstances surrounding falls and balance in this specific population. Therefore, we conducted a 3-month prospective follow-up study to determine the risk factors for falls with a focus on balance among patients with schizophrenia hospitalized in the psychiatric ward. The recurrence of falls has been associated with a prolonged hospital stay, thus posing an obstacle to patient discharge [8]. We believe that our findings can help facilitate the development of effective interventions for fall prevention in this specific population.

Methods

The study included patients with schizophrenia hospitalized in the psychiatric ward. The inclusion criteria were as follows: age 20 years or older, independent ambulation, no requirement for walking aids, no history of head injury, permission from the attending physician, and written informed consent.

An investigator performed baseline assessments of postural sway and maximum step length (MSL) in all participants. A 3-month follow-up of fall incidents was conducted after the baseline assessments. Data on fall incidents were collected from the participants themselves or from medical staff members. A fall was defined as an event that resulted in a patient unintentionally touching the ground, floor, or a lower level with body parts, such as the knee, upper limb (i.e., arm or hand), buttock, and hip [9]. Data, including age, sex, length of hospital stay, body mass index, daily typical or atypical antipsychotic dose (chlorpromazine equivalent), presence or absence of benzodiazepine use, and presence or absence of falls within 3 months before follow-up, were also collected from patient medical records.

Static postural stability was measured according to the range of trunk motion with eyes open and closed for 30 s. Assessments were performed with Win-Pod (Medicapteurs, Toulouse, France), which is a plantar pressure distribution measurement device. Postural instability

was quantitatively evaluated using the total sway length and ellipse area, which represented the distance traversed by the center of pressure on a force plate. Smaller ranges for the total sway length and ellipse area indicate better stability. We analyzed the total sway length and ellipse area as well as their Romberg quotients.

The difference between predicted and observed MSL values was used to assess inaccurate perception of physical fitness. Predicted values were obtained by asking participants to estimate the distance traveled when exerting maximum effort to take a single step. Then, with eyes looking straight ahead and feet initially placed together, the participants exerted maximum effort to take a step forward with one leg and then brought the other leg forward so that both feet would be aligned. The distance between the toes of the arbitrarily chosen swinging and supporting limbs during the step was designated as the observed value.

The participants were divided into a fall or non-fall group according to the fall incidents during the 3-month follow-up period, and variance among individual variables was analyzed using the *t*-test, Mann–Whitney *U* test, and chi-square test. Two-tailed *p* values were calculated for all tests, and the significance level was set at $p < 0.05$. All statistical analyses were performed using the IBM Statistical Package for the Social Science (SPSS) ver.24.0 J for Windows (IBM Corp., Armonk, NY, USA).

Results

A total of 120 individuals met the inclusion criteria and were thus included in this study. None of the participants refused baseline assessments. During the 3-month follow-up period, 16 (13.3%) of the 120 participants experienced falls.

The Shapiro–Wilk test for normality detected non-normal distributions for all variables. Thus, the Mann–Whitney *U* test was used to compare the variables between the fall and non-fall groups. There were significant differences in the presence or absence of falls within 3 months before follow-up ($p = 0.002$) and Romberg quotients for sway length ($p = 0.02$) between the two groups. The differences for all other variables were insignificant (Table 1).

Discussion

Previously, Poster et al. [1] found that 11.8% of study participants experienced falls over a 34-month period. Additionally, Tsai et al. [10] reported a fall rate of 8.6% over a 7-month period. These studies examined patients hospitalized in the psychiatric ward due to various conditions. In contrast, the present study focused on patients with schizophrenia and noted a fall rate of 13.3% over a 3-month follow-up period, which is relatively consistent with the rates reported by these previous studies.

A comparison of background factors revealed that fall history within 3 months before follow-up was significantly related to the subsequent occurrence of falls. This supports the observation of previous research that a history of falls increases the risk of future falls among psychiatric inpatients [11]. Therefore, a history of falls might be a useful indicator for fall prevention.

To our knowledge, this is the first prospective cohort study to examine the relationship between falls and balance in patients with schizophrenia. With regard to postural sway data, a significant difference was detected in only the Romberg quotient for total sway length, and it was lower in the fall group than in the non-fall group. The Romberg quotient is a type of

Table 1 Comparison of variables between the fall and non-fall groups

	Fall group ($n = 16$)				Non-fall group ($n = 104$)				p value
	Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum	
Age (years)	64.6	14.8	34.0	89.0	59.0	13.0	20.0	85.0	0.12
Sex (male/female)	(6/10)				(64/40)				0.07
Length of hospital stay (days)	5629.3	7491.8	236.0	23,346.0	4510.0	5125.8	19.0	20,987.0	0.79
Body mass index (kg/m^2)	23.1	2.7	16.8	27.8	22.2	3.7	13.6	33.3	0.36
Falls within 3 months before follow-up (±)	(5/11)				(4/100)				<0.01
Chlorpromazine equivalent									
Typical antipsychotics	220.3	238.5	0	750.0	254.1	370.9	0	1635.0	.42
Atypical antipsychotics	353.9	400.7	0	1400.0	457.0	449.4	0	2000.0	0.68
Benzodiazepine use (±)	(11/5)				(62/42)				0.48
Sway length (eyes open)	585.1	258.9	179.3	1079.8	477.5	177.7	167.7	1020.0	0.08
Ellipse area (eyes open)	567.7	450.0	89.5	1726.2	442.0	377.4	35.7	2878.0	0.36
Sway length (eyes closed)	601.4	199.5	290.0	985.6	664.0	313.8	250.1	2174.5	0.59
Ellipse area (eyes closed)	608.7	446.2	139.7	1929.0	602.2	426.8	46.7	2318.7	0.93
Romberg quotients for sway length	1.1	0.4	0.6	2.2	1.4	0.4	0.5	3.2	0.02
Romberg quotients for ellipse area	1.3	0.7	0.6	3.3	1.7	1.3	0.2	9.6	0.24
MSL predicted	69.9	26.3	30.0	110.0	83.6	21.4	30.0	150.0	0.05
MSL observed	73.1	25.7	31.0	101.0	85.9	23.8	20.0	130.0	0.12
MSL difference	−3.1	12.6	−26.0	19.0	2.3	19.6	−55.0	90.0	0.82

MSL maximum step length

balance test that is employed to assess the contribution of visual information to the maintenance of a standing posture. The quotient is determined by calculating the sway ratio between eyes-closed and eyes-open conditions. A value of ≥1.0 is indicative of a greater degree of movement with eyes closed. Although Romberg quotient values were > 1.0 for both groups, the value was larger for the non-fall group than for the fall group, demonstrating that vision played a considerable role in postural control. Postural control relies on input from the vestibular, visual, and proprioceptive systems; thus, sway increases when the eyes are closed and visual information is blocked. However, the fall group had a Romberg quotient for sway length of 1.15, indicating a minor change in the magnitude of sway between the eyes-open and eye-closed conditions when visual information was obstructed. With consideration to previous reports stating the eyes of patients with schizophrenia can be affected by structural and functional deficits [12–15], visual contribution to posture might be limited even when the eyes are open. Furthermore, the findings that the fall group exhibited less visual contribution to postural control and similar magnitude of sway with eyes open or closed suggest that such patients might possess a heightened ability to rely on senses other than vision. Therefore, frequency analysis could be useful for assessing the vestibular and proprioceptive systems in this population. Considering the abovementioned results, a Romberg quotient for sway length of around 1.0 can be considered as a factor related to falls. In the future, it will be necessary to examine the associations among falls, postural sway, and vision, and to assess the vestibular and proprioceptive systems in patients with schizophrenia.

The present preliminary study had several limitations. First, only 16 participants experienced falls during the follow-up, which was an insufficient sample size for logistic regression analysis. The determination of predictors will require analysis of the risk factors for falls in a larger sample. Second, although the present study attempted to comparatively analyze the fall and non-fall groups by measuring postural sway at baseline and then conducting a 3-month prospective follow-up, it did not explore the association between postural sway and psychiatric and extrapyramidal symptoms. Consequently, future research should examine how the Romberg quotient for sway length obtained in our study relates to psychiatric and extrapyramidal symptoms.

Compliance with Ethical Standards

Conflicts of Interest The authors declare that they have no conflict of interest.

Ethical Approval This study was conducted after being granted approval by the Hiroshima University Institutional Review Board for Epidemiological Research (approval number: E-569; approval date: November 7, 2016). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Poster EC, Pelletier LR, Kay K. A retrospective cohort study of falls in a psychiatric inpatient setting. Hosp Community Psychiatry. 1991;42:714–20.
2. Vaughn K, Young BC, Rice F, Stoner MH. A retrospective study of patient falls in a psychiatric hospital. J Psychosoc Nurs Ment Health Serv. 1993;31:37–42.

3. Tsai KY, Lee CC, Chou YM, Shen SP, Su CY, Wu HC, et al. The risks of major osteoporotic fractures in patients with schizophrenia: a population-based 10-year follow-up study. Schizophr Res. 2014;159:322–8.
4. An FR, Xiang YT, Lu JY, Lai KY, Ungvari GS. Falls in a psychiatric institution in Beijing, China. Perspect Psychiatr Care. 2009;45:183–90.
5. Tseng CC, Su PY, Huang HT, Chang YC, Tai YM. Risk factors for inpatient falls at a mental hospital. Taiwan J Psychiatry. 2013;27:131–9.
6. Marvel CL, Schwartz BL, Rosse RB. A quantitative measure of postural sway deficits in schizophrenia. Schizophr Res. 2004;68:363–72.
7. Koreki A, Tsunoda K, Suzuki T, Hirano J, Watanabe K, Kashima H, et al. Clinical and demographic characteristics associated with postural instability in patients with schizophrenia. J Clin Psychopharmacol. 2011;31:16–21.
8. Greene E, Cunningham CJ, Eustace A, Kidd N, Clare AW, Lawlor BA. Recurrent falls are associated with increased length of stay in elderly psychiatric inpatients. Int J Geriatr Psychiatry. 2001;16:965–8.
9. Gibson MJ. Falls in later life. In: Evans JG, Kane RL, McFadyen D, editors. Improving the health of older people: a world view. New York: Oxford University Press; 1990. p. 296–315.
10. Tsai YF, Witte N, Radunzel M, Keller ML. Falls in a psychiatric unit. Appl Nurs Res Schizo. 1998;11:115–21.
11. Chan CH, Gau SS, Chan HY, Tsai YJ, Chiu CC, Wang SM, et al. Risk factors for falling in psychiatric inpatients: a prospective, matched case-control study. J Psychiatr Res. 2013;47:1088–94.
12. Punukollu B, Phelan M. Visual acuity and reported eye problems among psychiatric in-patients. Psychiatr Bull. 2006;30:297–9.
13. Viertiö S, Laitinen A, Perälä J, Saarni SI, Koskinen S, Lönnqvist J, et al. Visual impairment in persons with psychotic disorder. Soc Psychiatry Psychiatr Epidemiol. 2007;42:902–8.
14. Zheng W, Tang LR, Correll CU, Ungvari GS, Chiu HF, Xiang YQ, et al. Frequency and correlates of distant visual impairment in patients with schizophrenia, bipolar disorder, and major depressive disorder. East Asian Arch Psychiatry. 2015;25:115–21.
15. Silverstein SM, Rosen R. Schizophrenia and the eye. Schizophr Res Cogn. 2015;2:46–55.

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