Journal of Diabetes and Its Complications 29 (2015) 898–902

Contents lists available at ScienceDirect

Journal of Diabetes and Its Complications

journal homepage: WWW.JDCJOURNAL.COM

Risk factors associated with falls in elderly patients with type 2 diabetes

Yuko Chiba *, Yoshiyuki Kimbara, Remi Kodera, Yuki Tsuboi, Ken Sato, Yoshiaki Tamura, Seijiro Mori, Hideki Ito, Atsushi Araki

Department of Diabetes, Metabolism, and Endocrinology, Tokyo Metropolitan Geriatric Hospital, 35–2, Sakae-cho, Itabashi-ku, Tokyo, 173-0015, Japan

ARTICLE INFO

Article history:
Received 12 January 2015
Received in revised form 13 May 2015
Accepted 26 May 2015
Available online 1 June 2015

Keywords:
Hypoglycemia
Falls
Elderly type 2 diabetes
Impaired balance
Sarcopenia
Frailty

ABSTRACT

Aims: This study investigated risk factors of falls in elderly patients with type 2 diabetes mellitus.
Methods: A total of 211 patients aged ≧60 years (168 diabetic patients and 43 non-diabetic control subjects) were studied. Factors associated with falls in the past year were retrospectively examined using multiple logistic regression analysis.
Results: The prevalence of patients who had a history of falls in the past year was twice as high as in diabetic patients compared in control subjects (36.9% vs. 18.6%, $P < 0.05$). When diabetic patients were exclusively analyzed, the presence of any level of hypoglycemia and the Timed Up and Go test (TUG) scores correlated with patients' falls. The presence of hypoglycemia (OR 3.62, 95% CI: 1.242–10.534, $P = 0.018$), cognitive impairment (OR 3.63, 95% CI: 1.227–10.727, $P = 0.020$), and high Fall Risk Index scores (OR 1.2, 95% CI: 1.010–1.425, $P = 0.039$) was independently correlated with the presence of multiple falls. When the diabetic patients were divided into three groups according to the frequency of hypoglycemia episodes, the prevalence of falls increased as the frequency of hypoglycemia increased.
Conclusion: Hypoglycemia was a risk factor of falls in elderly type 2 diabetic patients.

1. Introduction

The prevalence of type 2 diabetes mellitus is increasing worldwide, and the disease has become a significant public health problem in individuals of all ages (Zimmet, Alberti, & Shaw, 2001). Falls in diabetic patients may lead to disabilities and a lower quality of life (QOL). Repeated incidence of falls, even if not complicated with fractures, lowers the patient's motivation and ability to perform activities of daily living (Kim et al., 2001). Elderly individuals with type 2 diabetes often exhibit greater impairments in posture and gait and are typically at an increased risk of falling (Maurer, Burcham, & Cheng, 2005; Schwartz et al., 2002). A previous history of falls, poor lower extremity function, poor balance, a history of coronary heart disease (CHD), arthritis, being overweight, musculoskeletal pain, depression, poor vision, polypharmacy including hypnotics, peripheral neuropathy, and insulin therapy is associated with an increased risk of falling in diabetic patients (Volpato, Leveille, Blaum, Fried, & Guralnik, 2005).

The relationship between HbA1c and the risk of falls is more likely U-shape at different levels of HbA1c. For example, Yau et al. (2013) reported that hyperglycemia (HbA1c > 8%) as well as poor balance were risk factors for fall injuries requiring hospitalization in elderly diabetic patients. On the contrary, Nelson, Dufraux, and Cook (2007) demonstrated that the risk of falls in community-dwelling diabetic patients aged ≧75 years markedly increased when HbA1c was ≦7%, regardless of their frailty status. A cohort study using well-functioning older adults showed that the use of insulin and a lower glycemic control (HbA1c ≦6%) increased the risk of falls, although no correlation between HbA1c level and oral hypoglycemic medications was observed (Schwartz et al., 2008).

Johnston, Conner, Aagren, Ruiz, and Bouchard (2012) indicated that severe hypoglycemic events were independently correlated with an increased risk of fall-related fractures, but the relationship between mild hypoglycemia and falls in elderly diabetic patients remains unknown.

The aim of the present study was to investigate risk factors of fall in elderly diabetic patients.

2. Materials and methods

2.1. Study participants

A total of 211 individuals aged ≧60 years, who visited the outpatient clinic of the Department of Diabetes, Metabolism, and Endocrinology, Tokyo Metropolitan Geriatric Hospital, Japan, for at least a year, were recruited for the study. Patients were registered from December 2009 to April 2011. Exclusion criteria included blindness, wheelchair/bedridden condition, end-stage renal disease (dialysis therapy period), advanced-stage dementia (almost cannot communicate), adrenal insufficiency, hypopituitarism, hypo/

Conflicts of interest: None.

* Corresponding author. Tel.: +81 3 3964 1141; fax: +81 3 3964 1982.
E-mail address: chibaytky2004@yahoo.co.jp (Y. Chiba).

http://dx.doi.org/10.1016/j.jdiacomp.2015.05.016
1056-8727/

hyperthyroidism, and uncontrolled hypertension (systolic blood pressure > 180 mmHg). A total of 168 type 2 diabetic patients and 43 age-matched, non-diabetic control subjects participated in this study. Control subjects had been visiting the hospital for the treatment of hyperlipidemia and/or hypertension. Lipid levels and blood pressure were well controlled in these patients, and patients with underlying disease were excluded. A written informed consent was obtained from all patients.

The participants were interviewed by a professional interviewer for approximately 30–60 min, and they answered questionnaires about the frequency of falls, hypoglycemia, the risk of falls, the activities of daily living (ADL), depressive symptoms, and cognition. The study was approved by the hospital ethics committee.

2.2. Medical history and diabetic complications

Medical history including diabetic complications and the number and types of medications were recorded in medical charts. Diabetic retinopathy was assessed by funduscopic examination on dilated pupils by experienced ophthalmologists using direct ophthalmoscopy. Findings were classified into four stages: no retinopathy, background retinopathy, pre-proliferative retinopathy, and proliferative retinopathy. According to the lowest urinary albumin-to-creatinine ratio (ACR; mg/g creatinine) in two or three successive urinalyses, nephropathy was classified into four stages. Diabetic neuropathy was defined as the loss of bilateral Achilles tendon reflexes, diminished vibration sensation, and/or neuropathic symptoms, such as the lowering of sense and thermal nociception, or a history of foot ulcers or gangrenes. Stroke, CHD, and peripheral vascular disease were clinically diagnosed as reported elsewhere (Araki et al., 2012).

2.3. Falls and fall risk

A fall was defined as an unexpected event in which the person comes to rest on the ground, floor, or lower level. The frequency of falls in the past one year was investigated using the questionnaire about the number and type of falls (non-injurious or injurious falls, complicated with a head-injury or fractures). Multiple falls were defined as ≧2 falls a year. The risk of fall was assessed using the 21-item Fall Risk Index by Toba, Kikuchi, Iwata, and Kozaki (2009), which included physical, psychological, and environmental factors, and the total Fall Risk Index score was calculated.

2.4. Physical, psychological, cognitive function, and physical performance

To assess ADL, depression, and cognition, the 13-item ADL score (Tokyo Metropolitan Institute of Gerontology Index of competence: TMIG index) (Shibata, Sugisawa, & Watanabe, 2001), the 15-item geriatric depression scale (GDS-15) (Sheikh & Yesavage, 1986), and the Mini-mental state examination (MMSE) (Folstein, Folstein, & McHugh, 1975) were used. Physical performance was assessed using the Timed Up and Go test (TUG test) (Nordin, Lindelèof, Rosendahl, Jensen, & Lundin-Olsson, 2008), the functional reach test as a dynamic balance test (Duncan, Weiner, Chandler, & Studenski, 1990) was conducted and grip power was also measured.

2.5. Assessment of hypoglycemia

Hypoglycemia was defined as the presence of autonomic and neuroglycopenic symptoms of hypoglycemia, which recovered promptly (within 10 min) after the intake of glucose or sucrose. The frequency of mild or severe hypoglycemia was assessed using questionnaires (e.g., number of hypoglycemic episodes, number of comas or emergency hospital visits, or admissions due to hypoglycemia). Mild hypoglycemia was defined as the appearance of hypoglycemic symptoms with prompt recovery by self-administered intake of sugar or glucose, whereas severe hypoglycemia was defined as the occurrence of coma, convulsion, or inability of self-management and recovery from hypoglycemic symptoms (American Diabetes Association Workgroup on Hypoglycemia, 2005). The frequency of hypoglycemia that was self-reported by diabetic patients using the questionnaires correlated well with that judged by attending medical doctors in our previous study ($r = 0.796$, $P < 0.001$, $n = 855$) (Araki et al., 2012). Diabetic patients were divided into three groups according to the frequency of hypoglycemia: no hypoglycemia, hypoglycemia once or twice a year, and hypoglycemia ≧ three times a year.

2.6. Statistical analysis

The clinical characteristics and possible risk factors for falls were compared between the diabetic and non-diabetic control groups, or between diabetic patients with and without any falls. The differences of continuous variables between the two groups were analyzed using the Student's t test or Mann–Whitney U-test, where appropriate. The difference of prevalence was analyzed using the Pearson's chi-square test. The linear trend between the frequency of hypoglycemia and falls was assessed using the Mantel–Haenszel linear-by-linear association chi-square test.

To examine the independent determinants of falls, we performed multiple logistic regression analysis using the significant variables in univariate analysis ($P < 0.05$): age, sex, cognitive impairment (MMSE < 26), TUG score, GDS-15 scores, the Fall Risk Index, and the presence of hypoglycemia. We used the Hosmer–Lemeshow goodness-of-fit statistic, which is more precise than the traditional goodness-of-fit statistic used in logistic regression. Unadjusted and adjusted odds ratios for falls were estimated for each risk factor. All analyses were conducted using IBM SPSS Statistics 18 (Japan IBM, Tokyo), and $P < 0.05$ was considered statistically significant. Data were presented as mean ± standard deviation (SD) unless otherwise specified.

3. Results

There were no significant differences in age, sex, or BMI between control and diabetic groups. Diabetic patients showed higher systolic blood pressure, lower ADL, and higher GDS-15 scores. In the TUG test, diabetic patients spent more time completing the test than control subjects ($P < 0.001$). Total scores of the Fall Risk Index were also significantly higher in diabetic patients than in control subjects ($P < 0.001$; Table 1).

The prevalence of those who had a history of at least one episode of any type of fall over the past year was twice as high in diabetic patients as in control subjects (36.9% vs. 18.6%, $P = 0.023$).

In diabetic patients, the mean HbA1c was 7.4 ± 0.8% (Table 1). The mean duration of diabetes was 18 ± 11 years. A total of 52.1% of patients were treated with sulfonylurea, 49.1% with biguanides, 23.7% with thiazolidinedione, 36.1% with α-glucosidase inhibitor, and 19.5% with insulin.

When diabetic patients were exclusively analyzed, the HbA1c level in diabetic patients with falls was similar to that in patients without falls (7.4 ± 0.9% vs. 7.4 ± 0.8%). Further analysis revealed that there was no significant trend in the increase or decrease in the frequency of falls among the three HbA1c groups (<6.5%, 6.5%–7.2%, >7.2%). Even if we divided subjects into two groups according to HbA1c levels (≦7.9% vs. ≧8.0%), similar results were obtained (29.4% vs. 37.7%, $P = 0.602$).

The prevalence of any hypoglycemic episodes (once or more per year) was significantly higher ($P = 0.036$) in diabetic individuals with any fall (35.5%) than in those without them (20.8%; Table 2). The mean HbA1c level was not different between diabetic patients with and without any fall. Diabetic patients with falls had a significantly