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Prevention of falls in community dwelling elderly: The relationships among history of falls, change in contact surface of the foot, standing balance, and muscle strength over a one-year period

Tomoko Hiramatsu Kiyoko Izumi Miho Shogenji Mayumi Kato*

Key words

prevention of falls, community-dwelling elderly, contact surface of foot,
standing balance, muscle strength

INTRODUCTION

Falls of elderly people can be the result of complex combinations of various factors. A fall can lead to a reduction in the QOL of the elderly people, as be bed-ridden. Preventing falls is important, if elderly people are to continue independent life in communities. We thought it is one of the fall prevention for the elderly that clarify risk factor for fall that a prediction rate is high and can show by way of prevention. The present study was undertaken to investigate in diachronically of fall-related risk factors among independent community-dwelling elderly. Therefore, as risk factor of the fall which could intervene in a subject, we gave standing stability, standing balance and muscle strength of lower extremities and investigated. The result and the incidence of falls during the survey period was analyzed with relation to history of falls that the most probable risk factor for fall¹⁾⁻³⁾.

Methods

1. Subjects

The subjects of this study were 47 independent community dwelling elderly individuals who attended a health learning course held 2 times a month (with a one-hour exercise and lecture on health at each session) and who could be followed up for one year.

2. Methods of data collection

1) Measurement of physical function : Indicators of physical function were selected, using the criteria of established reliability and validity, widespread use and ease of measure⁴⁾⁻⁷⁾. Stability while standing was evaluated by measuring the contact surface of foot, using the Visual Pedometer System (Seitai Kagaku Kenkyusho). This system is designed so that when the subject stands on the test stand, the contact of the toes and the sole is measured and the contact surface is depicted in the form of colored images. The color of the image changes in 5 steps depending on the pressure level.

The amount pressure is indicated in descending order from white (highest) to red to yellow to green to blue (lowest). Stability was rated as good or poor according to the intensity and distribution of contact pressure of the toes and the sole. Contact was rated as good if the area of contact by the big toe was greater than that by the other toes and half of the four smaller toes (second third fourth fifth toe) were depicted in colors other than blue. Any other type of contact was rated as poor. The sole was evaluated using pressure distribution as an indicator. Cases showing high pressure distribution on the heel or the outer edge of the sole were rated as having poor soles, and all

Graduate School of Medical Science Division of Health Sciences kanazawa university

* School of Health Sciences, Faculty of Medicine, Nigata University

other cases were rated as good. Static balance was evaluated by calculating postural sway area during 20-second sessions of standing with both eyes open or closed, using a GS10 Gravicorder(Anima KK). Dynamic balance was evaluated by a functional reach test. Muscle strength of the lower extremities was evaluated by measuring the maximum isometric muscle strength during flexion and extension of the knee joint, using a μ TasMT1 manual muscle-strength analysis system(Anima KK). Measurements were made twice (September 2003 and September 2004).

2) History of falls were investigated by a self-entry using selective structured questionnaires during the same time the subjects were seen for measurement of physical function. Subjects were asked about presence on history of fall in the past one year. Then the elderly with history of fall was investigated about situation of fall, injury by fall and fear of falling.

3. Statistical analysis

The change of functional ability and falls during this study was analyzed about each subject with history of falls in past year. Chi-square test and t-test were employed for statistical analysis. $P < 0.05$ was regarded statistically significant. $P < 0.1$ was regarded tend to significant.

4. Ethical considerations

Each candidate for the study was informed in writing as to the design and ethical aspects of the study. Those who gave their consent were enrolled in the study. Ethical aspects of the study stated to the

candidates were: (1) each individual could participate or quit the study at his/her own discretion; (2) the data collected during the study would not be used for any other purpose than the scope of this study; and (3) the anonymity of each subject would be strictly maintained. Methods involving lower levels of physical and psychosomatic stresses were selected to obtain the measurements, and primary importance was attached to safety.

Results

1. Subjects' background variables

The subjects with history of falls (fallers group) was 10, including 1 male (10.0%) and 9 females (90.0%). Their mean age was 75.8 ± 9.0 years. The subjects without history of falls (non-fallers group) was 37, including 9 males (24.3%) and 28 females (75.7%), with a mean age of 71.2 ± 12.2 years. About 80% of the fallers group and of the non-fallers group had some health problem (most frequently hypertension). 9 (90.0%) in the fallers group had lumbago or pain in the knee as did 18(48.6%) in the non-fallers group ($p < 0.05$). Palsy was not found in any subject in either group.

2. Annual changes in physical function analyzed in relationship with history of falls (Table 1)

When physical functioning was analyzed at the start of the study in relationship with history of falls, the poor contact surface of toes was found among 4 subjects(40.0%) from the fallers group and 5(13.5%)

Table 1. The relationship between history of falls and change in functional ability over a one-year period

Item		the fallers group n=10	the non-fallers group n=37
Contact surface of toes (poor)	beginning to investigate	4 (40.0)	5 (13.5) †
	over a one-year period	6 (60.0)	1 (2.7) *
contact surface of sole (poor)	beginning to investigate	4 (40.0)	14 (37.8)
	over a one-year period	5 (50.0)	13 (35.1)
Area of postural sway (open)	beginning to investigate	$4.4 \pm 3.8^{1)}$	2.5 ± 1.7
	over a one-year period	3.2 ± 1.8	2.9 ± 1.7
Area of postural sway (close)	beginning to investigate	$5.5 \pm 5.5^{1)}$	3.1 ± 1.5
	over a one-year period	4.5 ± 2.9	4.2 ± 2.1
Functional reach test	beginning to investigate	$31.9 \pm 5.2^{2)}$	32.6 ± 4.9
	over a one-year period	30.2 ± 2.0	31.3 ± 6.4
Muscle strength	beginning to investigate	male	$23.9^{3)}$
		female	17.9 ± 6.6
	over a one-year period	male	20.7
		female	19.9 ± 8.4
			29.2 ± 8.9
			19.2 ± 4.5
			29.8 ± 9.6
			$22.2 \pm 5.5^*$

1) cm² 2) cm 3) kg * $p < 0.05$ † $p < 0.1$

from the non- fallers group($p<0.1$). In another item, the relationship with history of fall was absent.

When physical functioning was analyzed at over a one-year period in relationship with history of falls, the poor contact surface of toes was found among 6 subjects(60.0%) from the fallers group and 1(2.7%) from the non-fallers group($p<0.05$). Muscle strength of the lower extremities of males was 20.7 kg in the fallers group and 29.8 ± 9.6 kg in the non- fallers group. Muscle strength of the lower extremities of females was 19.9 ± 8.4 kg in the fallers group and 22.2 ± 5.5 kg in the non-faller group ($p<0.05$). In another item, the relationship with history of fall was absent. None of the indicators differed between the measurement at the beginning of the study and the measurement conducted one year later.

3. Falls during the study period analyzed in relationship with history of falls(Table 2)

Three subjects(30.0%) in the fallers group fell during the one-year period after the start of the study and 1(2.7%) fell in the non-fallers group($p<0.05$). In the fallers group, 2 subjects fell indoors and 1 fell outdoors during the study period, in all these cases, the cause of the fall was stumbling over an object, the injury by falls was contusion or cuts. In the non-fallers group, the fall was caused by slipping on a snow-covered road, and the subject sustained a contusion due to the fall. There were no significant differences in physical function between the subjects who fell and the subjects who did not fall during the study period. The state of contact surface of toes was poor in all subjects. Muscle strength of all but one subject in the fallers group was lower than the average muscle strength of those in the fallers group.

Four subjects (40.0%) in the fallers group often stumbled indoors and 3(8.1%) in the non-fallers group ($p<0.05$). The number of subjects who is very scary

with the fear of falling was 5(50.0%) in the fallers group and 7(18.9%) in the non-fallers group.

Discussion

From The results of the present study, subjects with history of falls are more likely to fall afterwards than those without such history. This finding is identical to other reported¹⁾⁻³⁾ previously, and we was able to confirm that experience of falls is an important factor of predictor of the possibility of falls by elderly people independent of daily activity in community dwelling. The cause of falls were often stumbling over objects, and many of the subjects who had history of falls answered that their falls often occurred indoors. These findings suggest the necessity of intervention to prevent stumbling for elderly people.

Indicators found to be associated with history of falls were contact surface of toes and muscle strength of the lower extremities. An association between falls and contact surface of toes was also revealed in survey of frail elderly⁸⁾. Therefore we think that an important risk factor of fall for the elderly is contact surface of toes. Standing balance was not associated with history of falls, and the functional reach test was over 25 cm⁹⁾ in all subjects, it is thought that the dynamic balancing function had been preserved well in the subjects of this study. As for healthy elderly people in community dwelling, reinforcement of muscle strength and balance function is discuss⁹⁾¹⁰⁾, and results of the present study suggest that problem of the foot related to the stability of standing position may be also importance. The present study researched on contact surface of foot while stand still for the elderly, but falling occur when they walk or move the center of gravity, so that in the future, it is necessary that the relationship between contact surface of foot and center of gravity is examined in detail. In addition,

Table 2. The relationship between history of falls and fall

Item	the fallers group n=10	the non- fallers group n=37
Fall for investigation period	3 (30.0)	1 (2.7) *
Often stumbled indoors	4 (40.0)	3 (8.1) *
Fear of falling	very scary	5 (50.0)
	little scary	5 (50.0)
	not scary	0 (0.0)
		7 (18.9)
		18 (48.6)
		12 (32.4)

* $p<0.05$

lowering of muscle strength has been pointed out as a risk factor of fall¹¹⁾, but the cut-off value of muscle strength has not been identified. Therefore it may be necessary to examine the changes of muscle strength diachronically and the cause of such changes.

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地域高齢者の転倒予防 — 転倒経験と接地足跡, 立位バランス, 下肢筋力の経年的変化との関係 —

平松 知子, 泉 キヨ子, 正源寺美穂, 加藤真由美