

# Prevention of falls for daycare use elderly: The relationship of ground contact pressure of toes, sole pressure distribution, toe-gap force, life style and falls

メタデータ	言語: eng 出版者: 公開日: 2017-11-09 キーワード (Ja): キーワード (En): 作成者: メールアドレス: 所属:
URL	<a href="http://hdl.handle.net/2297/6096">http://hdl.handle.net/2297/6096</a>

# Prevention of falls for daycare use elderly : The relationship of ground contact pressure of toes, sole pressure distribution, toe-gap force, life style and falls

Tomoko Hiramatsu    Kiyoko Izumi    Miho Shogenji

## KEY WORDS

toes, sole, elderly, prevention of falls

### Introduction

The prevention of falls for the elderly is very important, because falls can result in their becoming bed-ridden and thus reducing their Quality of Life (QOL). It is thought that it is important to preserve and improve muscular strength and posture-control capabilities, for falls are to be prevented<sup>1)</sup>. Maintaining an upright position involves the working of the toes and the soles. Toes are also involved in stabilizing the body in various postures<sup>2-5)</sup>. As for the action to maintain a function of a foot part, it is effective for the prevention of falls of the particularly frail elderly in a community-dwelling, but the actual situation is not clarified under the present conditions.

Therefore, to collect data for prevention of falls, we investigated a ground contact state of toes in a standing posture of the daycare use elderly, and we made a study of the relationship of ground contact pressure of toes, sole pressure distribution, toe-gap force, life style and falls.

### Methods

#### 1. Subjects

The subjects of this study were 17 daycare use elderly in the community-dwelling as the A facility who consented to cooperate with this study. At this facility, user of daycare had been made aware of the importance of the order of movement when walking, i.e., contacting the ground with the heel and then with the toes.

#### 2. Methods of data collection

1) The state of contact of the subject's toes and soles with the ground or floor was measured twice (in August 2004 and 6 months later), using the Visual Pedometer System (Seitai Kagaku Kenkyusho). This system is designed so that when the subject stands on the test stand, the state of contact of the toes and the sole with the stand 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). The toe was evaluated with ground contact pressure. Parts of the foot which were demarcated well and presented in colors other than blue were checked. 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 three smaller toes (second through fourth toe) were depicted in colors other than blue. Any other type of contact was rated as poor. The sole was evaluated with a state of pressure distribution. Cases showing high pressure distribution on the heel or the outer edge of the sole were rated as having poor soles, and all other cases were rated as good.

2) Toe-gap force was measured using a Toe Checker (Shinkikaku Publishing Co., Ltd.). Toe-gap force indicates the strength of a pinch made between the big toe and the next one. This kind of strength has been considered an indicator of foot muscle function

because it correlates with the muscular activity around the ankle joint<sup>6)</sup>. This strength is measured in the following way. The subject sits on a chair, with the knee bent to form a right angle. The subject places one foot on the device, and attempts to pinch the protruding part of the device between the first and second toes. This measurement was done twice for each foot. The greater of the two measurements was adopted as the toe-gap force for its side. Normally men have a toe gripping strength over 3 kg and women have a grip strength over 2.5kg<sup>6)</sup>.

3) Life style and past experiences with falls were investigated by a structured interview, using a selection type questionnaire.

### 3. Statistical analysis

The relationship of the ground contact pressure of toes, sole pressure distribution, toe-gap force, life style and falls was analyzed. Chi-square test and t-test were employed for statistical analysis.  $P < 0.05$  was regarded statistically 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 in 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 stress were selected to obtain the measurements, and primary importance was attached to safety.

## Results

### 1. Time course of profiles and ground contact pressure of toes of subjects

The ground contact pressure of toes was rated as good in 9 subjects (52.9%), all of whom were female. Their mean age was  $80.9 \pm 8.2$  years. The ground contact pressure of toes was rated as poor in 8 subjects (47.1%), including 4 males and 4 females, with a mean age of  $77.8 \pm 8.0$  years. The number of subjects who had at least one of stroke, Parkinsonism,

osteoarthritis and diabetes mellitus was 7 (77.8%) in the good ground contact pressure of toes group and 4 (50.0%) in the poor ground contact pressure of toes group. The number of subjects who were receiving oral treatment with at least one of hypotensors, sleeping pills and tranquilizers was 3 (33.3%) in the good ground contact pressure of toes group and 4 (50.0%) in the poor ground contact pressure of toes group. The number of subjects who complained of at least one of paralysis, leg pain and dizziness was 6 (66.7%) in the good ground contact pressure of toes group and 5 (62.5%) in the poor ground contact pressure of toes group.

When changes in ground contact pressure of toes between the first and second measurements were analyzed, 6 subjects (66.6%) of the good ground contact pressure of toes group had maintained good ground contact pressure of toes 6 months later, while 3 (33.4%) from this group showed deterioration of the ground contact pressure of toes. Of the 8 subjects who were initially rated as having poor ground contact pressure of toes, none showed a change in the pressure 6 months later.

### 2. Relationship between ground contact pressure of toes and fall (Table1)

The number of subjects who had experienced fall during the past one year period was 2 (22.2%) in the good ground contact pressure of toes group and 6 (75.0%) in the poor ground contact pressure of toes group ( $p < 0.05$ ). None of the two subjects with an experience of fall from the good ground contact pressure of toes group showed a change in the ground contact pressure of toes during the six-month follow-up period. The number of subjects who were seized with the fear of fall was 2 (22.2%) in the good ground contact pressure of toes group and 4 (50.0%) in the poor ground contact pressure of toes group. Of these subjects with fear of fall, 1 (50.0%) from the good ground contact pressure of toes group and 3 (75.0%) from the poor ground contact pressure of toes group actually experienced a fall.

Table 1. The relationship between ground contact pressure of toes and fall

Item	Ground contact pressure of toes	
	good n=9	poor n=8
History of fall	2 (22.2)	6 (75.0) *
Fear of falling	2 (22.2)	4 (50.0)

\* p&lt;0.05

Table 2. The relationship between Ground contact pressure of toes and Sole pressure distribution or Toe-gap force

Item	Ground contact pressure of toes		
		good n=9	poor n=8
Foot sole pressure distribution	good	5 (55.6)	4 (50.0)
	poor	4 (44.4)	4 (50.0)
Toe-gap force <sup>1)</sup> (kg)	the right of woman	1.2±0.9	0.8±0.3
	the left of woman	1.1±0.5	0.8±0.6

1) Toe-gap force of woman (good n=9, poor n=4)

### 3. Relationship among ground contact pressure of toes, sole pressure distribution and toe-gap force (Table2)

In the good ground contact pressure of toes group, the sole pressure distribution was poor in 4 subjects (44.4%). In the same group, the toe-gap force was  $1.2 \pm 0.9$  kg on the right side and  $1.1 \pm 0.5$  kg on the left side. In the poor ground contact pressure of toes group, the sole pressure distribution was poor in 4 subjects (50.0%). In the same group, the toe-gap force for females was  $0.8 \pm 0.3$  kg on the right side and  $0.8 \pm 0.6$  kg on the left side, and the toe-gap force for males was  $2.2 \pm 0.6$  kg on the right side and  $2.4 \pm 1.2$  kg on the left side. There was no significant correlation between the ground contact pressure of toes and sole pressure distribution or toe-gap force.

### 4. Ground contact pressure of toes and life style

#### 1) Lifestyle in the good ground contact pressure of toes group

Five subjects (55.6%) required an appliance for movement. The number of subjects who practiced walking outdoors 5 times or more in a week was 5

(55.6%). The most frequent purpose of outdoor activity was to have a walk. The number of subjects who were aware of the order of movement during walk (first the heel and then the toes) was 4 (44.4%). One subject (11.2%) often used a pair of slippers when walking. Five subjects (55.6%) lived in a Japanese type room with the floor covered with Tatami carpets. At night, 6 subjects (66.6%) slept on bed. A Western style toilet was used by 8 subjects (88.8%). Three subjects (37.5%) often stumbled indoors.

#### 2) Life style in the poor ground contact pressure of toes group

Six subjects (75.0%) required an appliance for movement. The number of subjects who practiced walking outdoors 5 times or more in a week was 7 (87.5%). The most frequent purpose of outdoor activity was to have a walk. The number of subjects who were aware of the order of movement during walk (contacting the ground with the heel and then with the toes) was 3 (37.5%). No subject from this group often used a pair of slippers when walking. Six subjects (75.0%) lived in a Japanese type room with the floor covered with Tatami carpets. At night, 6 subjects (75.0%) slept on bed. A Western style toilet was

used by 7 subjects (87.5%). Three subjects (37.5%) often stumbled indoors.

### Discussion

Of frail elderly living in the community who seemed to require special care for the prevention of falls, those who visited a day service facility and received training on walking were enrolled to this study. Of all subjects, 47.1% had poor ground contact pressure of toes. The ground contact pressure of toes was found to correlate with the incidence of fall. The percentage of individuals with poor ground contact pressure of toes was higher in the present study than in a previous study of health elderly individuals (30%)<sup>7)</sup>. Toes play a significant role in stabilizing the posture during standing or walking<sup>2)</sup>. If the ground contact pressure of toes is inadequate, the individual cannot kick well when walking or stand firm when resuming balance, leading to a higher likelihood of falling. The toe gap force tended to be higher in the good ground contact pressure of toes group, but it was lower than the normal value. These results suggest the necessity of reinforcing the foot muscle strength of these subjects. Although several studies of the relationship between reinforcement of toe-gap force and prevention of falls have been reported<sup>8-10)</sup>, there is no consensus over an optimum method of training or the efficacy of such training. Further studies are needed on this topic.

A limitation of this study is the small number of subjects. It is desirable that the function of toes and the relationship between toes and falls are studied in a larger number of subjects, to collect basic data which will be useful in devising valid care for the prevention of falls by elderly people.

### Conclusion

To collect data which would help devise valid means of preventing falls, we analyzed relationship of ground contact pressure of toes, sole pressure distribution, toe-gap force, life style and falls by elderly individuals visiting a day service facility. There was no significant correlation between ground contact pressure of toes and sole pressure distribution or toe-gap force or life style. But the ground contact pressure of toes was poor in 47.1% of the subjects and it was found to correlate with the incidence of fall. These results suggest the necessity of studying further about a function of toes of these individuals.

### References

- 1) Povince, M.A. et al. : The effects of exercise on falls in elderly patients a preplanned meta-analysis of the FICSIT trials. *JAMA*, 273 : 1341-1347, 1995.
- 2) Asai, K. et al. : Function of the toes in standing. *PT Journal*, 23(2) : 137-141, 1989 (in Japanese).
- 3) Kabe, N. et al. : The study of relationship between toe and dynamic postural control. *Rigakuryouhoukagaku*, 17(3) : 199-204, 2002 (in Japanese).
- 4) Mann, R.K. et al. : The function of the toes in walking jogging and running, *Clin. Orthop.*, 142 : 24-48, 1979.
- 5) Ihara, H. et al. : *Kansetsu training 2 ed.* 89-107, Kyoudo-uiseyo, Tokyo, 1996 (in Japanese).
- 6) Yamashita, K. et al. : Evaluation of the Aged against Tumbling by Toe-Gap Force. *Keisokuzidouseigyogakkai-ronbunshuu*, 38(11) : 952-957, 2002 (in Japanese).
- 7) Hiramatsu, T. et al. : Tentouyobou ni kansuru tiiki-koureisya no sokutei no zittai. *JSNR*, 27(3) : 210, 2004 (in Japanese).
- 8) Handa, S. et al. : A study on the measurement of toes grasping strength and effect of standing postural control. *Ningenkougaku*, 40(3) : 139-147, 2004 (in Japanese).
- 9) Kito, N. et al. : Effects of toe motion exercise to prevent falls in the elderly. *Rigakuryouhougaku*, 28(7) : 313-319, 2001 (in Japanese).
- 10) Kobayashi R. et al. : Effects of toe grasp training for the aged on spontaneous postural sway. *JTOM*, 47(10) : 633-636, 1999 (in Japanese).

## 通所サービス利用高齢者の転倒予防

—足指接地力と、足底圧分布、足指間圧力、日常生活および転倒との関係—

平松 知子, 泉 キヨ子, 正源寺美穂