

# Effects of Rollator Handle Type on Plantar Foot Pressure During Gait by Elderly Women

SEON-CHIL KIM, PhD<sup>1</sup>), MYOUNG-HEE LEE, PhD, PT<sup>2</sup>),  
SANG-YEOL LEE, PhD, PT<sup>3</sup>), YOUNG-IK LEE, PhD<sup>4</sup>)

<sup>1</sup>Department of Radiologic Technology, Daegu Health College

<sup>2</sup>Department of Physical Therapy, Daegu Health College: Taejun-dong, Bukgu, Daegu, 702-722  
Republic of Korea.

TEL: +82 53-320-1438, FAX: +82 53-320-1350, E-mail: mhlee0317@hanmail.net

<sup>3</sup>Department of Physical Therapy, Gimhea College

<sup>4</sup>Department of Oriental Sports Medicine, College of Health & Therapy, Daegu Haany University

**Abstract.** [Purpose] The purpose of this study was to investigate the effect of handle type, which is a fundamental element determining rollator type and the part that directly connects the user to a rollator, on the plantar foot pressure of elderly people during gait, and to examine how the gait of elderly people is affected by variation of the rollator handle. [Subjects] The subjects of this study were 12 elderly women over the age of 65 and 10 young adults who were given sufficient explanation about the objectives and method of this study and volunteered to participate in the study. [Methods] The elderly women learned how to use different types of rollators and performed gait without a rollator and with two types of rollators in a random order on a course that was 10 m long. The young adults, who served as the reference for the plantar foot pressure during gait, performed gait in the same manner without a rollator. [Results] The plantar foot pressure of the elderly people was compared with that of the young adults. The results show that there was a significant difference at the rearfoot, lateral midfoot, lateral forefoot, and hallux regions. The plantar foot pressure at the rearfoot and hallux regions was highest in the young adults, while it was lowest when the elderly used a rollator with a transverse handle. The plantar foot pressure at the lateral midfoot and lateral forefoot regions was highest when the elderly group did not use a rollator. [Conclusion] The results suggest that selective use of the handle type according to the purpose is important even though the use of a rollator assists the gait of the elderly regardless of the handle type. Moreover, the high dependency on the transverse handle rollator means that there can be a greater risk of falling down when grip on the handle is lost, and the vertical handle is more appropriate for gait training since it reduces dependency on the rollator during gait.

**Key words:** Elderly women, Plantar foot pressure, Rollator

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## INTRODUCTION

There is a decline in flexibility, muscle strength, and cognitive skills, which can lead to balance disability with aging<sup>1</sup>), and the number of the elderly people who experience falls is increasing. Many elderly people use more than one gait assistance tool in order to prevent falls<sup>2</sup>). Particularly for women, balance ability decreases with age after menopause, and various gait assistance tools are used to compensate for decreased balance ability. Use of a gait assistance tool is greatly helpful for the elderly in their daily living activities, since it not only improves their balance ability, but also decreases the pain caused by degenerative diseases by reducing the load on the joints of the lower limbs during gait<sup>3</sup>). Many walking aids have been developed for the daily living activities of elderly people. Among them, the rollator minimizes the reduction of physical strength that accompanies the use of general walking aids, and gait with a rollator is similar to that without a rollator<sup>4</sup>). Among the many walking aids, the rollator is highly

evaluated in terms of stability and improvement in gait efficiency, and because of such advantages, the number of elderly people using a rollator is increasing<sup>5</sup>). The four-wheel type gait assistance tool that is used for gait by elderly people who are able to walk independently is called a silver-car, and it consists of handle, frame, and stopper. Some of the silver-cars have a seat or a basket that are used for rest or carrying objects<sup>6</sup>).

Although many elderly people use various types of rollator for the prevention of falls and for convenience in daily living activities, most studies of rollators have compared use with nonuse of a rollator<sup>7</sup>). Recently, rollators have developed focusing on design and convenience of use for the elderly and they are being used for purposes other than their original purpose. However, studies of rollators' stability and gait improvement of elderly people, in addition to design and convenience, have yet to be conducted.

Therefore, in this study, we investigated the effect of the handle type, which is fundamental element determining the rollator type and the part that directly connects the user to

**Table 1.** Comparison of plantar foot pressures of each group under the various gait conditions. (Unit: kPa)

Area	EP	EP-VH	EP-TH	YA
M1*	143.0 ± 6.6	122.6 ± 6.3	116.1 ± 7.0	184.6 ± 12.2
M2	106.4 ± 13.2	98.2 ± 16.0	87.1 ± 11.5	78.9 ± 7.0
M3*	113.3 ± 6.1	92.0 ± 6.8	95.5 ± 5.8	83.7 ± 6.4
M4	188.2 ± 7.5	172.0 ± 9.7	156.4 ± 6.4	197.9 ± 18.7
M5	166.8 ± 7.0	147.6 ± 5.2	148.7 ± 4.5	166.6 ± 11.5
M6*	158.2 ± 7.2	128.8 ± 8.0	128.3 ± 6.1	127.7 ± 11.2
M7*	148.3 ± 14.1	132.6 ± 9.7	122.6 ± 7.1	230.6 ± 20.6
M8	127.6 ± 10.1	110.5 ± 10.0	106.8 ± 8.4	106.8 ± 11.2

mean ± SE. The asterisk (\*) indicates significance at the  $p < 0.05$  level. EP: elderly people group; EP-VH: elderly people using vertical handle; EP-TH: elderly people using transverse handle; YA: young adults group. M1: Rearfoot; M2: Medial midfoot; M3: Lateral midfoot; M4: Medial forefoot; M5: Middle forefoot; M6: Lateral forefoot; M7: Hallux; M8: Lesser toes.

the rollator, on the plantar foot pressure of elderly people during gait, and examined how the gait of elderly people is affected by variation in the rollator handle.

## SUBJECTS AND METHODS

The subjects of this study were 12 elderly women over the age of 65 and 10 young adults who were given sufficient explanation about the objectives and method of this study who volunteered to participate in the study. The subjects satisfied the following criteria no history of neurological diseases, no experience of musculoskeletal damage in the past six months, ability to walk 10 meters independently, and MMSE (mini-mental state examination) of 24 or higher.

A Pedar-X Mobile System (Novel, GMBH, Munich, Germany) was employed to investigate the patterns plantar foot pressure changes induced by use of a rollator. The subjects wore the same running shoes of appropriate size for their feet. Three insole type pressure sensors with different sizes were inserted into the shoes to measure the plantar foot pressure during gait at a sampling rate of 50 Hz.

To collect precise data, the weights of the subjects were and the calibrated before starting the gait experiment. The elderly women learned how to use the different types of rollators and performed gait without a rollator and with two handle types in a random order on a course that was 10 m long. The subjects were asked to walk at the speed that was most comfortable for them. The young adults served as a reference for plantar foot pressure during gait, and they performed gait in the same manner as the elderly without a rollator. Data were collected in the middle 6 m of the course, excluding the 2 m at the start and end points. The mean peak pressure under the dominant foot was analyzed. To analyze the peak pressure, the foot was divided into eight regions: rearfoot, medial midfoot, lateral midfoot, medial forefoot, middle forefoot, lateral forefoot, hallux, and lesser toes<sup>8)</sup>.

The data were analyzed using the commercial software, PASW 18.0. A one-way ANOVA was performed to compare plantar foot pressures among gait without a rollator, gait with a vertical handle rollator (such as bicycle handle), and

gait with a transverse handle rollator (such as a horizontal bar). The post-hoc test was performed by Scheffe. The significance level,  $\alpha$ , was chosen as 0.05.

## RESULTS

The Body Mass Index (BMI) of the young adults ( $n=10$ ), the control group that was used to examine plantar foot pressure, was  $22.2 \pm 0.9$ , and that of the elderly group was  $20.5 \pm 0.7$ , without significant difference ( $p > 0.05$ ). The mean age of the young adults was 28.2, and that of the elderly group was 71.4.

The plantar foot pressure of the elderly people was compared with that of the young adults, and there were significant differences between the young and the elderly at the rearfoot, lateral midfoot, lateral forefoot, and hallux regions ( $p < 0.05$ ) (Table 1). The plantar foot pressure at the rearfoot and hallux regions was highest in the young adults, while it was lowest when the rollator with a transverse handle was used by the elderly. The plantar foot pressure at the lateral midfoot and lateral forefoot regions was highest when the elderly group did not use rollator.

## DISCUSSION

The rollator, a gait assistance tool for the elderly, provides stability through the wide base of support (BOS), and improves gait by increasing the walking speed because of the wheel at the front. Since many elderly persons use a rollator for these reasons, various rollators have been developed as commercial advantages are sought, though design has mainly focused on convenience, and there have been insufficient studies of the stability of the elderly and gait improvement, the essential purpose of a rollator. Additionally, feet play an important role in gait and daily living and are closely related to gait stability since they determine the BOS<sup>9)</sup>. Hence, in this study, we investigated the effects of handle type on the gait of the elderly when using a rollator by measuring the plantar foot pressure changes with type of handle, through which users directly contact with the rollator and transfer weight to it.

The results of this study show that the plantar foot

pressure at the rearfoot was lower in the elderly group than in the young adults group. The plantar foot pressure was larger when the vertical handle rollator was used than when the transverse handle rollator was used. This may be because the transverse handle rollator is more focused on gait assistance than gait improvement as the user is more dependent upon this type of rollator than the vertical handle rollator. The plantar foot pressure of the elderly at the hallux region was also lower than that of the young adults, and it was higher when the vertical handle rollator was used than when the transverse handle rollator was used. This indicates that the transverse handle rollator allows gait even when the driving force is not provided by the hallux region at the time of toe-off since more user weight is supported by the transverse handle rollator than by the vertical handle rollator. Therefore, gait may be helped by the vertical handle rollator as an elderly person maintains the original gait pattern, whereas the transverse handle rollator allows gait with less energy consumption in the interval between toe-off and heel-strike as it assists gait more, although it does alter the original gait pattern.

The plantar foot pressure at the midfoot and forefoot regions is closely related to the stability in the swing phase during gait, and it is low if the gait is unstable<sup>10</sup>). In the present study, the plantar foot pressures at the lateral forefoot and lateral midfoot regions of the elderly not using a rollator were different from those of the young adults, and those of the elderly using a rollator indicate that a rollator provides stability.

The present results also suggest that selective use of handle type, according to the purpose, is important even

though the use of a rollator assists the gait of the elderly regardless of the handle type. Moreover, the high dependency on the transverse handle rollator means that there is a greater risk of falling if grip on the handle is lost, and that the vertical handle is more appropriate for gait training since it reduces the rollator dependency during gait.

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