

外国語要旨

学位論文題目 Evaluation of gait abilities in elderly people by using the novel foot pressure shoes

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Hip fracture in the elderly is a serious problem resulting in individuals being bedridden. This does not only decrease quality of life, but also create an important burden to the society and a rise of medical expenses. Some studies have used specialized equipment to evaluate the gait function in elderly. However, although very accurate, the current methods may present some limitations. For instance, they are not easy to use outside medical facilities, which limits their usage for the prevention of fall risk in less medicalized environments like senior community dwellings or health community centers. According to the guidelines for the prevention of fall in older persons of the American Geriatrics Society et al. the factors impacting fall risk are age (>80 years), history of falls, etc. (American Geriatrics Society et al, JAGS, 2001). In the present manuscript, we developed an original tool allowing a quantitative evaluation of the gait function.

In a previous study, Saito et al. developed a custom-built plantar pressure measurement device. This device consisted of seven pressure-sensitive electric rubber sensors and a wireless unit, which transmits the obtained data to a control personal computer, thus enabling plantar pressure measurements. The work presented in this manuscript improved the original device designed by Saito et al. The new device now enables measurements of plantar pressure during unrestricted movements and allows the subject to wear normal shoes. An instant feedback smartphone application has been developed. The new wireless transmission system uses Bluetooth with a sampling frequency of 100 Hz and has a maximum transmission distance of about 50 m. All these new features reduce the burden on subjects and allows gait measurements to be carried out more easily, e.g. in community centers.

We tested the validity of the new device was verified by comparing its performances with some other reference methods. In comparison experiments with a stabilometry and F-scan II, there were high correlation coefficients. The new device was used in two field experiments. First, we conducted plantar pressure measurements in 98 subjects in a health community center and performed a cross sectional analysis. Second, we conducted a 1-year intervention study in 37 of these subjects and repeat the measurements at the end of the intervention period.

The purpose of the cross-section study was to elucidate the differences in walking patterns depending on age and history of fall. Thirty-nine healthy subjects (mean age, 59.8 ± 6.3 years) and 59 community-dwelling elderly peoples (mean age, 74.6 ± 4.9 years) were recruited. In this experiment, subjects were asked to wear the shoe device and walked 10-m at their own pace. Subjects were classified into three groups depending on their age and history of fall in the past year (healthy middle age adults, non-faller elderly, elderly fallers). Normal gait in healthy people usually implies high plantar pressure at heel contact and toe off, resulting in a bimodal pressure profile. In the present, we quantitatively assessed these heal-toe bimodal pattern. The plantar pressure measurements significantly differed between groups for heel, toe but also center midfoot sensors. Briefly, healthy subjects exhibited high pressure values at heel contact and toe off with a clear bimodal pattern, while low plantar pressures and no clear bimodal pattern was detected in both non-faller and faller elderly. It can be assumed that elderly fallers have features of shuffle along. On the other hands, center midfoot plantar pressures were significantly higher in elderly compared to healthy middle age adults and also most importantly higher in faller elderly compared to non-faller elderly ($p < 0.05$). The center midfoot sensor is very specific of the foot arch and therefore inform on the absorption of foot impact during walking. In addition, different walking patterns (regarding plantar pressure measurements) have been detected depending on age and tendency to fall (Nakajima et al. T&HC 2014).

The intervention study had two main objectives: 1) to validate the effectiveness of one foot care intervention to improve walking abilities in elderly, and 2) to characterize quantitatively the pre- / post- intervention changes using the new device. The intervention consists in monthly foot care given by foot care professionals. Foot pressure measurements were performed before and at the end of the intervention using the same 10-m walking test. Twelve people (32% of the entire subjects) showed improvement of foot deformities, and 25 people (68%) were able to maintain foot condition (i.e. no further deterioration). Some improvements of plantar pressure have been observed in subjects who presented severe foot deformities at baseline (e.g. ingrown nail, thickened nail, foot corn...). It was thought that foot care related toe off during gait or related loading improved their gait function. According to our findings, a simple foot care intervention might be an effective fall prevention strategy in elderly people.

In conclusion, we developed novel foot pressure shoes. This easy-to-use device is suitable for a usage in non-medicalized environment like health community centers or senior community dwellings. The results confirmed that valid quantitative measurements representative of the gait features can be obtained and help the management of fall risk in Japanese elderly.