ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, *Vol 8(27), DOI: 10.17485/ijst/2015/v8i27/81706, October 2015* ISSN (Online) : 0974-5645

Comparison of Foot Pressure on Forward and Backward Walking in the Adults

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Abstract

The backward walking can be used as an exercise program mainly after injury. However, the present reality is such that studies evaluating the effect of backward walking through the foot pressure are lacking. The purpose of this study was to evaluate the changes in foot pressure through forward and backward walking training before and after the interventions by group. The subjects for this study were 20 people in control group, and 20 people in the experimental group. Measurement tool used was the gait analyzer. All subjects were evaluated in the same manner for the foot pressure before and after the intervention. Interventions were conducted five times a week for four weeks, 30 minutes a day. After having light clothing and flat shoes, subjects walked forward in the control group, while the subjects walked backward in the experimental group. As a result, there was no significant difference in foot pressure between the control and the experimental group. However, in the control group, F2, F5, and R4 showed statistically significant reduction in pre- and poet-test. In the experimental group, F5 and F6 showed statistically significant reduction in pre and poet-test. It is considered that the results of this study could be used as a basis when applying the backward walking training in the clinical trials.

Keywords: Backward Walking, Forward Walking, Foot Pressure

1. Introduction

With a rising interest in health in recent years, more and more people are becoming the enthusiasts for outdoor sports such as marathon, cycling, mountaineering etc., and especially some young women are enjoying cardio workout such as walking or running for weight loss[1]. Walking is easy to perform without special equipment or economic investment, yet it improves aerobic capacity[2].

Backward walking is being carried out on a regular basis in life, even if it is a common action for most people[3]. In addition, since there is a risk of worsening pain for people with problem in the muscle-skeletal system after walking for a significant amount of time, it is backward walking that can be an alternative to these people[4]. Ever since the study of backward walking began in the early 1980s[5], a variety of studies on backward walking has been conducted.

The gait cycle of forward walking is all the process that takes place while the same leg is carrying out two times of consecutive initial contact, which is occurring in the following order, initial contact, loading response, mid stance, terminal stance, pre-swing, initial swing, mid swing, and terminal swing[6]. On the other hand, the stand period of backward walking refers to the movement with toes touching the ground first and then the heels touching the ground. Reversing from forward- to backward-treadmill walking features a decrease in gait velocity, stride length, and duration of swing phase, and an increase in the double-support phase[7]. Backward walking can correct the bodily position required to perform a variety of tasks[8], consume 38-119% more energy than the forward walking when the speed of both walking is the same, and shows higher muscle activity than forward walking[9]. In addition, as the load acting on ankle and knee joints is being distributed to other muscles because the toes hit the ground first, the stress of the joint is being reduced.

Because of this advantage, the bacwkward walking

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can be used as an exercise program mainly after injury[7]. Furthermore, it has also been reported that backward falls are common in the elderly and that hip fractures often result from these falls[10]. Therefore, there has been a lot of research going on about the backward walking. In a study of muscle activity of healthy adults, the activity in the rectus femoris muscle and tibialis anterior muscle increased when walking backward than forward[4]. In a study evaluating the balance ability of school-aged boys, the overall balance ability increased significantly after 12 weeks of training backward walking[12].

Walking of human behavior requires various mechanisms such as implementation of the conduct of anti-gravity, balance, and stepping forward[13]. Among several methods to assess body's ability to balance, the assessment of skeletal muscle balance using electromyography and the assessment of physique balance through foot pressure assessment have been recognized as a way with high reliability recently[14].

Through foot pressure, one can observe pressure applied to a specific part of feet during the various activities of daily living and functional activities[15]. However, the present reality is such that studies evaluating the effect of backward walking through the foot pressure are lacking. Therefore, the purpose of this study was to evaluate the changes in foot pressure through forward and backward walking training before and after the interventions by group.

2. Methods

2.1 Subjects

Subjects of this study were 40 healthy male and female in their 20s being enrolled in K University, with 20 students in the control group for forward walking task, and 20 students in the experimental group for backward walking task. As the experiment was not to analyze the foot pressure according to the sex difference between the male and female, the subjects were selected at random for the control and treated group without sex distinction. People with problems with walking because of the medical history related to muscle-skeletal system, nervous system, or mental problem, and people who practiced walking backward or sideways during the last three months were excluded from the study. This study conformed to the ethical principles of the Declaration of Helsinki and subjects signed a written informed consent before participation.

2.2 Instrument and Intervention

Measurement tool used was the foot pressure. Using the gait analyzer, TS-GT001010, from a domestic company Desktop (Inc.), the dynamic foot pressure was measured during forward walking and backward walking on the flat floor in a laboratory (Figure 1). The plantar area is divided into 10 regions (Figure 2). In walking forward measurement, the subjects were in comfortable clothing, in barefoot, with the eyes staring toward the front and reach right heel, and in order to measure the gait cycle, the hitting of the right heel, the hitting of the left heel, and back to the hitting of the right heel were measured. With the same method, in measuring the walking back, the hitting of the right toe, the hitting of the left toe, and back to hitting of the right toe were measured. The foot pressure was measured three times and an average value was calculated to be used in the analysis of the result. All subjects were evaluated in the same manner for the foot pressure before and after the intervention. Interventions were conducted five times a week for four weeks, 30 minutes a day. After having light clothing and flat shoes, subjects walked forward in the control group, while the subjects walked backward in the treated group.

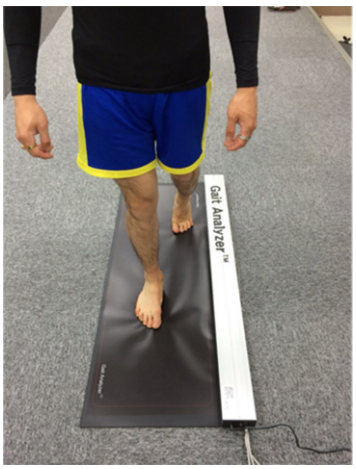

Figure 1. Foot pressure measurement by gait analyzer.

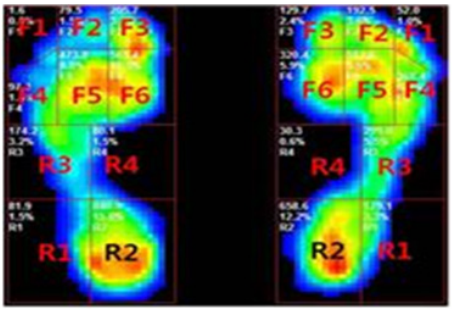

Figure 2. 10 regions of plantar area.

2.3 Data Analysis

For the data analysis of this study, SPSS version 20.0 (SPSS, Chicago, IL, USA) was used for the statistical processing. To calculate the average values of the general characteristics of the subjects, and to compare the foot pressure before and after the exercise, the paired t-test was carried out, while to compare the foot pressure difference between the groups, independent sample t-test was used. The significance level was chosen as $\alpha = 0.05$.

3. Results

The subjects for this study were 20 people in control group (men 9, female 11), and 20 people in the experimental group (8 males and 12 females), and the general characteristics of them are as follows (Table 1).

Table 1. Subject characteristic

Table Column Head		
Table column subhead	**Forward walking (M±SD)**	**Backward walking (M±SD)**
Age(year)	21.05±1.57	21.25±1.86
Sex(M/F)	9/11	9/12
Height(cm)	168.45±9.04	166.7±8.39
Weight(kg)	64.18±13.77	62.44±14.58

Foot pressure in the control and experimental groups according to the intervention is as follows: There was no significant difference in foot pressure between the control and the experimental group. However, each group showed difference before and after the interventions. In control group (forward walking group), the foot pressure showed statistically significant reduction in F2, F5, and R4. And the foot pressure in the experimental group (backward walking group) showed statistically significant reduction in F5, and F6 (Table 2).

4. Discussion

There are in general a forward walking, backward walking, and side walking in types of walk[16]. Among them, in the case of backward walking, there is less risk of shock to the joints than the forward walking where the movement is possible only when the ankles are fixed and the knees and the legs are in flexion[17], and also there is the effect to make patellofemoral joint and femoral muscle active in more balanced ways[18]. However, the present situation is such that there is a lack of studies evaluating the impact of foot pressure. Therefore, in this study, the change of foot pressure in each group was analyzed after each forward

Table 2. Comparison of foot pressure in pre and post-test of each group

Table Column Head					
Region		**Pre-test (M±SD)**	**Post-test (M±SD)**	**t**	**p**
F1	FW	0.49±0.91	0.50±0.62	-0.02	0.98
	BW	0.56±0.70	0.58±0.47	-0.15	0.89
F2	FW	9.85±5.40	6.97±3.23	3.07	0.01*
	BW	9.24±4.58	7.96±3.87	1.03	0.32
F3	FW	18.54±4.91	17.14±3.73	1.61	0.12
	BW	17.39±6.85	14.98±5.37	1.47	0.16
F4	FW	19.10±6.47	11.40±5.18	4.56	0.58
	BW	13.47±6.08	12.48±6.02	0.56	0.58
F5	FW	56.71±16.28	35.88±11.92	6.89	0.01*
	BW	49.39±19.21	39.72±14.67	2.80	0.01*
F6	FW	40.94±14.90	34.93±12.34	1.61	0.12
	BW	41.34±16.85	27.68±11.15	3.02	0.01*
R1	FW	25.96±22.78	24.07±15.47	0.46	0.65
	BW	22.64±22.23	21.14±26.83	0.22	0.83
R2	FW	110.24±47.13	90.39±38.74	2.00	0.06
	BW	114.45±50.59	97.35±45.88	1.61	0.12
R3	FW	27.40±13.25	21.15±25.22	0.92	0.37
	BW	22.04±14.17	19.27±9.66	0.93	0.36
R4	FW	7.67±5.88	3.35±3.66	3.63	0.00*
	BW	8.81±8.62	5.33±5.77	1.93	0.07

Footnotes. *$p<0.05$; FW = Forward Walking; BW = Backward Walking.

walking and backward walking was carried out five times a week for four weeks, 30 minutes a day.

Recent studies on foot pressure are some of the measurement targets at issue in the areas of clinic and research in exercise science and rehabilitation. Foot pressure is measured to quantify the static and dynamic pressure of the feet during the walk[19]. This foot pressure is used as an index to reflect the degree of balance of body by analyzing the state of structural and biomechanical function and the pattern of human gait[20,21].

There was no statistically significant difference in the pressure of the control group and the experimental group in the results of this study. In previous studies, the result of comparing walking forward, walking backward and walking sideway did not show any significant difference in any areas other than F1, F2[22]. On the other hand, the pressure before and after the interventions showed difference by group. In the control group (forward walking groups), F2, F5, and R4 showed statistically significant reduction in the foot pressure. In the experimental group (backward walking group), F5 and F6 showed statistically significant reduction in the foot pressure. This result is in agreement with the findings of previous study. The result of previous study on training of walking backwards with the target patients with diabetic peripheral neuropathy in the time span of 12-weeks, F5 and F6 showed a statistically significant decrease in the foot pressure[23].

The limitations of this study are as follows. First, the range of the subject selection was narrow. Second, it has been difficult to analyze the result of this study with significance due to the lack of the prior studies. Therefore, further research should be made dealing with the targets with a variety of ages and diseases. And the study of the impact of foot pressure during backward walking should be activated.

5. Conclusion

In conclusion, the foot pressure did not change between walking forward and walking backward. But the pressure in the medial mid-foot during backward walking training showed a statistically significant reduction. Therefore, it is considered that the results of this study could be used as a basis when applying the backward walking training in the clinical trials.

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