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Original Article

The effect of insole on muscle activity and muscle fatigue at sit to standing of tibialis anterior and gastrocnemius in adult male

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Abstract. [Purpose] The purpose of this study was to investigate the effect of differing insole height on the electromyographic (EMG) activity and muscle fatigue in tibialis anterior and gastrocnemius a lot of repeat college students from the desk during a sit to stand activity. [Subjects and Methods] For the 30 subjects males, let them wear insole in order. Using EMG equipment measured the difference in muscle vitality and muscle fatigue degree. All subjects were measured for 3 seconds in standing up from the chair. It has been measured total 3 times. [Results] The results stated above is as follows: It's sitting to standing activity when there were no significant differences between the muscles. But sitting activity in muscle fatigue−calf muscle during standing activity correlated only. [Conclusion] The results of this study show that the change of the muscle fatigue may cause an in gastrocnemius muscle, so not recommended for the health of a case of running shoes.

Key words: EMG, Insole, Muscle fatigue

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INTRODUCTION

Shoes are closely related to the social lives of modern people. Recently, their cosmetic aspects, not their social function, have been emphasized[1)]. Because of the increased interest in their appearance, many young men wear elevator shoes or insert insoles into sneakers in order to satisfy the aesthetic standard of being tall[2)]. Insoles can be inserted easily in sports shoes to absorb shock, to protect the ankle and knee joints, and to reduce the impact on the foot by distributing the weight, thus decreasing fatigue. In fitness training, the use of insoles can reduce the risk of injuries caused by overuse and the tibia stress syndrome[3)].

When they perform daily tasks, people consistently stand up from a sitting position. Standing up from a sitting position serves as a precondition for movement because it is required in order to walk[4)]. The leg muscles are used intensively in standing up from a squatting or a sitting-on-chair position. Standing up from a squatting position requires the greater use of leg muscles than standing up from sitting in a chair does. Even in a squatting position, the muscular activities vary based on the degree of knee bending. When such muscular activities persist, one or multiple functions may be generated, which results in muscle fatigue[5)].

In walking in high-heeled shoes, the muscular activities of some leg muscles increase proportionally as the heel height increases[6)]. A previous study investigated the effects of heel height in elderly women and young women. Heels that were 4 cm and higher affected balance and increased the risk of falling[7)]. According to another study that analyzed gait when the subjects used or did not use insoles, muscular activities were higher in the anterior tibialis and in the muscle biceps femoris during the stance period. They were also higher in the gastrocnemius muscle and the vastus lateralis in the swing position[8)].

Although several studies have examined the functions of insoles and the effects of heel height in women, few studies have focused on the use of insoles and the effects of heel height in men. Therefore, the purpose of this study was to investigate the effects of insoles on the muscular activities and fatigue of the anterior tibialis and the gastrocnemius muscle, which are mainly used standing up from a sitting position in adult male.

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SUBJECTS AND METHODS

After thoroughly explaining the purpose and methods of this study to the potential subjects, we selected 30 healthy male college students in their 20s, who voluntarily agreed to participate in the study. The study purpose and methods were explained to the subjects, who provided informed consent according to the principles of the Declaration of Helsinki before participating. The heights of the insoles were 1.5 cm, 3.5 cm, and 5.5 cm, which could be easily inserted in loafers and canvas shoes, which young men commonly wear. We used the 3 cm insoles for tennis shoes that were available in the market. Electromyography (EMG) pads were attached to each subject. All subjects wore the insoles, sat on a chair, and repeated the action of squatting and standing up three times. The investigator measured the muscular activity during all three actions. The resting time between the measurements of the actions was three minutes.

The EMG equipment (WEMG-8, Laxtha, Korea) was used to measure the anterior tibialis and the gastrocnemius muscle. To measure the anterior tibialis, the pads were attached to an area exactly halfway between the center of the kneecap and the lateral ankle bone. To measure the gastrocnemius muscle, the pads were attached to a lateral surface 2 cm below the hamstring midline. Based on the data collected from the EMG measurements, the muscular activities and fatigue values of each channel were determined by using the root mean squared (RMS) and the mean edge value (MEV). Both items were measured three times to calculate the mean value used in the data analysis[9)].

SPSS version 17.0 for Windows was used for the data analysis. Friedman's nonparametric test was used to compare the average values of the muscular activities and the fatigue based on the heights of the insoles. The Wilcoxon test was used for the post test. Statistical significance was α=0.05.

RESULTS

Table 1 shows the muscular activities and the degree of fatigue in the anterior tibialis and the gastrocnemius muscle according to the insole heights. The results showed no significant difference in in each group of muscular activities, whereas muscle fatigue was significantly different in the gastrocnemius muscle according to the height of the insole. When the fatigue values of the gastrocnemius muscles were compared between the groups, significant differences were observed at 3 cm vs. 5.5 cm (p=0.28), 1.5 cm vs. 5.5 cm (p=0.017), and 3.5 cm vs. 5.5 cm (p=0.037).

DISCUSSION

In this study, we investigated a sample of male college students, who frequently sit in chairs and stand up from the sitting position, in order to compare the activities and fatigue in the anterior tibialis and the gastrocnemius muscles, which are commonly used in sitting and standing. The participants were divided into three groups according to the height of the insoles inserted in their shoes during the experiment.

Wearing shoes with high heels for a long time while walking can be a major cause of foot deformity and pain[10)]. The muscular activities of the anterior tibialis based on heel height were found to be higher when the height was 9 cm than when

Table 1. Comparison of muscle activation and muscle fatigue

Muscle		Height	Frequency (Hz)
Muscle activity	Tibialis anterior	3 cm	66.9 ± 16.6*
		1.5 cm	64.6 ± 12.6
		3.5 cm	66.4 ± 11.7
		5.5 cm	67.5 ± 12.9
	Gastrocnemius	3 cm	33.4 ± 2.3
		1.5 cm	32.9 ± 2.4
		3.5 cm	33.4 ± 2.5
		5.5 cm	33.9 ± 2.9
Muscle fatigue	Tibialis anterior	3 cm	150.4 ± 26.2*
		1.5 cm	149.5 ± 23.8
		3.5 cm	152.8 ± 18.7
		5.5 cm	156.1 ± 24.6
	Gastrocnemius*	3 cm	236.5 ± 9.8
		1.5 cm	237.0 ± 7.5
		3.5 cm	237.5 ± 8.7
		5.5 cm	244.6 ± 12.9

*Mean (mm) ± SD.

it was 4 cm or 7 cm. According to other studies that investigated the use of insoles, muscular activities were higher in the anterior tibialis during the stance period when the soles touched the ground, and they were higher in the gastrocnemius muscle during the swing position[11]. This significant difference may be caused by the fact that the anterior tibialis, the flexor of the ankles and the knees, is highly activated during the stance period, whereas the gastrocnemius muscle, the extensor of the ankles and the knees, is highly activated during the swing period[12]. However, in the present study, no significant difference was found in the muscular activities between the two muscles based on the height of the insoles. A potential reason is that the participants were measured while they stood up from a sitting position, whereas in previous studies, the participants were measured while they were walking.

The results of the present experiment showed no significant difference in muscular activities according to insole height, but the degrees of fatigue in the gastrocnemius muscle were significantly different. In the between-group comparison of the muscle, significant differences were found in tennis shoes vs. 5.5 cm, 1.5 cm vs. 5.5 cm, and 3.5 cm vs. 5.5 cm.

The results of this study showed no significant difference in the muscular activities between the gastrocnemius muscle and the anterior tibialis muscle. It may be reasonable that the calf muscles did not show significant differences because the quadriceps femoris, the agonistic muscle in sitting and standing up, was activated. According to the results of a previous study, the gastrocnemius muscle and the anterior tibialis did not show differences in muscular activities based on the heights of lateral strap insoles perhaps because the passive structures, such as the ligaments around the knee joints, had a greater effect than the muscles did.

The degrees of fatigue in the gastrocnemius muscle showed significant differences between the groups. Prior studies of the effects of wearing elevator shoes reported that the muscle fatigue in the erector spinae and the gastrocnemius muscle increased[13]. This result may have been because the fatigue in the gastrocnemius muscle was higher than that of the anterior tibialis in subjects that wore insoles or elevator shoes when standing up from a sitting position. In walking up and down stairs, the young age group showed overall fatigue in the lower limb muscles, while the elderly age group had more fatigue in the quadriceps femoris, the anterior tibialis, the semitendinosus muscle, and the biceps femoris muscle than in the other lower limb muscles[14].

The results of this study have limited generalizability because we did not minimize the risk of placing excessive body weight on a single insole. Further studies should be conducted using various positions of male participants to identify problems and to contribute to the research.

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Conflict of interest

None.

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