

# Change in Lower Extremity Muscle Activity with Visual and Noises During Walking

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## Abstract

**Background/Objectives:** In this study, four conditions of visual and noises were examined to determine the inferior limb muscle activity after walking for 10 minutes on a treadmill.

**Method/Statistical Analysis:** Nine males and nine females, who agreed to participate in the study, were recruited. Participants were asked to walk on a treadmill for 10 minutes on each of the four conditions (a), (b), (c), and (d) depending on visual acuity and noise. Electromyograph was used to measure and compare muscle activity.

**Findings:** There was no significant difference in biceps femoris muscle ( $p > .05$ ). The comparison of the tibialis anterior muscle resulted in a significant difference between the conditions a-c, a-d, b-c and b-d ( $p < .05$ ). This indicates that conditions in those visually impaired became more vital in comparison to those that were not visually impaired. The muscle activation by condition was  $d > c > b > a$ , followed by de-conditioned vision and dB was the highest when it was higher 90. The comparison of the lateral gastrocnemius muscle resulted in a significant difference between the a-c, b-c and b-d conditions ( $p < .05$ ). This indicates that conditions without vision have become more vital than those with vision. The muscle activation by condition was  $d > c > b > a$ , followed by de-conditioned vision and dB was the highest when it was  $> 90$ . The comparison of the medial gastrocnemius muscle showed that not all four conditions differed significantly ( $p > .05$ ).

**Improvements/Applications:** There was significant difference in muscle activity between TA, LGM than when vision was blocked, that the muscle activity has improved when walking over 90 dB than 60 dB.

**Keywords:** Gait, Visual, Noise, Treadmill, Electromyography.

## Introduction

Walking is a routine human activity and a continuing event involving multiple systems simultaneously including the nervous system, sensory motor, musculoskeletal, and visual vestibular systems<sup>[1,2]</sup>. Walking is a very complex behavior, and normal walking should precisely control limb movements,

posture and strength, a very complex process involving the entire nervous system<sup>[1,3,4]</sup>. Human walking is one of the most common forms of exercise, but it is important to understand what specific functions of the leg can be used to perform effective walking<sup>[5,6]</sup>. Increasing walking speed increases leg muscle activity and energy consumption<sup>[2,7]</sup>. Visual deprivation of gait stability reduces dynamic stability and increases dependence on somatosensory and vestibular systems to control gait stability<sup>[4,8]</sup>. Walking is a beneficial means of transportation for individuals and communities and provides health benefits that improve balance, improve bone growth and improve mobility<sup>[2,9]</sup>. Today, the use of treadmills is used as a tool for rehabilitation and exercise as well as gait assessment, and treadmill training has become an important therapeutic

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intervention in neurological rehabilitation over the last few years<sup>[2,10]</sup>. The difference between walking on the ground and walking on the trade track is that people can choose speed, walk shorter or wider, and spend less time at the swing<sup>[11]</sup>. According to preliminary studies, only 90% of the information about the human brain is transmitted to the eye<sup>[12]</sup>. Obstructing other parts of the visual field, including the peripheral vision, has an important effect on gait dynamics<sup>[13,14]</sup>. Vision provides information about the environment from a distance and plays a crucial role in mobility in maintaining stability and path when visually recognizing the environment on the move. In order to adjust the foot spacing and foot position and to control the walking speed, it is important to visual recognition of self motion, limb position, and limb movement<sup>[15]</sup>. Auditory information affects the sensory motor control of gait. During walking, people are accustomed to body-related and environmental sounds, and the reduction of auditory information using active noise reduction has surprisingly improved walking stability when using active noise reduction compared to normal walking<sup>[16]</sup>. In addition, auditory noise has been shown to have additional effects on postural stability independent of vision<sup>[17]</sup>. Viljanen et al show that people with poor hearing are at high risk of falls and are partially explained by poor posture. For safe mobility, hearing information on the environment is important<sup>[18]</sup>. Previous studied physiological decline in visual, auditory, physical stability and muscle strength can mitigate accident risk and lead to slower defensive responses<sup>[19]</sup>. Hafström et al have shown that visual perception is important for controlling multiple senses in posture and contributes to spatial direction and self-motion perception<sup>[20]</sup>. Saucedo et al also provides essential sensory information to maintain dynamic stability during human motion<sup>[21]</sup>. Negahban et al report that hearing and vestibular systems are closely related anatomically and physiologically<sup>[22]</sup>. In previous studies, there have been studies to confirm the effects of visual, noise, and gait, but no studies have been done to confirm the gait activity of the gait with visual and noise. The purpose of this study was to investigate the effect of muscle activity on the gait during gait with respect to noise and visual acuity in healthy adult males and females.

## Method

The subjects of this study were 18 healthy adult students (9 males and 9 females) who were admitted to S university in Asan city, Chungnam. The general

characteristics of the participants are shown in [Table 1]. The study participants consisted of those who agreed to participate in the study, and the muscle activity was measured in the dominant foot direction. The EMG QUS100 (Zero Wire EMG, Italy, 2009) was used to measure muscle activation, with the biceps femoris muscle, the anterior tibial muscle, the lateral gastrocnemius muscle, and the medial gastrocnemius muscle. EMG was attached to each muscle after shaving to reduce skin resistance of EMG. When measuring the surface EMG, the sampling rate was 1024 Hz, the EMG signal was 1785 times, the bandpass filter was 20 to 500 Hz, and the notch filter was 60 Hz. The collected EMG signals were recorded in root mean square (RMS). In this study, one person participated in all four conditions and selected the subjects without musculoskeletal diseases according to four conditions according to the presence of visual block and decibel size. The test items were height, weight, and dominant foot. Before the experiment, subjects were instructed about the purpose of the experiment and the study procedure, and the same clothes were worn for the same settings of all the subjects. The first condition is that the eyes are not blocked on the treadmill and that you are walking at a comfortable speed for 10 minutes under 60dB. During walking, the gaze was directed toward the front. The second condition is that you do not block your eyes and you walk for 10 minutes at 90dB. During walking, the gaze was directed toward the front. The third condition is that you are walking at a comfortable speed for 10 minutes in an environment where the time is blocked and the decibel is below 60dB. SPSS/PC ver. 22.0 for windows program (SPSS INC, Chicago, IL). Each mean and standard deviation were calculated to see the characteristics of subjects, and one-way repeated measures ANOVA was used to see the activity of each leg muscle according to the conditions. A significant level of analysis of all statistics was set at  $p < .05$ .

## Result

Four conditions on the treadmill in the environment where the time is not blocked, the environment is 60dB or less, the time is not blocked, the environment is 90dB or more, the time is blocked, the decibel is 60dB or less, the time is blocked and the time is over 90dB. First, the results of biceps femoris muscle, there was no significant difference in all four conditions ( $p > .05$ ) Second, the results of tibialis anterior muscle, there was a significant difference between the conditions of a-c, a-d, b-c and b-d ( $p < .05$ )[Table 2][Figure 1].  $d > c > a > b$  are shown

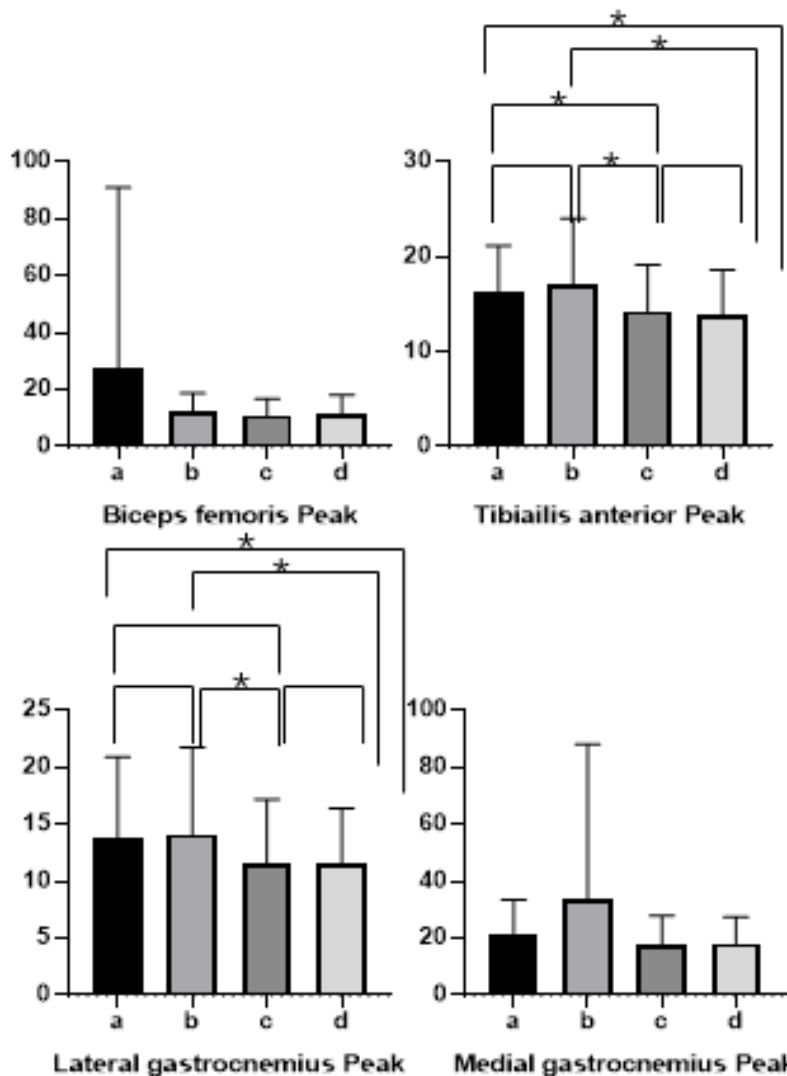
in [Table 2][Figure 1]. Third, The results of lateral gastrocnemius muscle, there was a significant difference between the a-c, b-c and b-d conditions ( $p < .05$ ) [Table 2] ][Figure 1] and  $d > c > a > b$  are shown in [Table 2] [Figure 1]. Fourth, the results of medial gastrocnemius muscle, there was no significant difference in all four conditions ( $p > .05$ ) [Table 2] [Figure 1].

**Table 1. Subject characteristics (n = 18)**

Characteristic	Value	
Gender	Male	n = 9
	Female	n = 9
Age (Year)	21.61±2.57	
Height (cm)	166.72±7.35	
Weight (kg)	61.22±13.67	
Dominant foot	Right	n = 16
	Left	n = 2

**Table 2. Comparison of the four conditions and the muscle maximum**

	60db with Visuala	90db with Visualb	60db without Visualc	90db without Visuald	F
BP	17.20±16.72	12.13±6.62	10.98±5.84	11.18±6.92	1.64
TP	16.26±4.89	17.03±7.00	14.28±4.87	13.93±4.72	5.72*
LGP	13.81±7.08	14.12±7.61	11.56±5.64	11.53±4.90	3.09*
MGP	21.80±11.69	33.70±54.46	17.85±10.00	18.22±9.23	2.05



**Figure 1. Comparison of the four conditions and the muscle maximum**

## Discussion

The purpose of this study was to investigate the change of muscular activity of the lower extremity muscles according to visual and loudness in human walking. As a result, there was a significant difference ( $p > .05$ ) between the mean and peak values of the tibialis anterior muscle group and the peak value of the lateral gastrocnemius muscle group ( $p > .05$ ) and the mean value and peak value of biceps femoris muscle and medial gastrocnemius muscle. There was no significant difference in the mean value of lateral gastrocnemius muscle. Mendonça et al attempted to observe the effect of a rhythmic signal while walking on a treadmill, because walking with his or her gait as an auditory cue synchronized with hearing cues, There was no difference between the effects of gait or music stimulation. This means that it is not effective to use his/her gait as an auditory clue and to use musical stimulation as an auditory cue<sup>[23]</sup>. In this study, musical stimulation due to difference in decibel influences muscle activity during gait. Do not. Saucedo et al reported that the decrease in stability due to visual deprivation during treadmill walking is similar among age groups. This suggests that visual deprivation, regardless of age, reduced gait stability<sup>[21]</sup>. In general, it is consistent with the study that muscle activation is more likely to occur when walking under conditions of walking without visual intervention than when walking with visual interception. However, when there is a difference in visual intercept, not all muscles show significant differences. There was no significant difference between biceps femoris muscle and medial gastrocnemius muscle. In this study, muscle activity showed the highest value when the time was blocked at the maximum value of tibialis anterior muscle and lateral gastrocnemius muscle. Hamacher et al reported that hearing information has an effect on walking control and improved walking stability when using active noise elimination compared to normal hearing. As a result, noise reduction is required to improve walking stability<sup>[16]</sup>. This is consistent with the results of our study that the condition of noise removal resulted in low muscle activity. Sejdic et al studied the effect of music appreciation on walking. Walking is accomplished through neural control systems such as visual, vestibular, and proprioceptive systems, and walking with music leads to a more unstable stride interval sequence than with no music. This means that walking with music is unstable walking<sup>[24]</sup>. In this study, we prove that the effect of muscle activity is affected by presenting unstable walking factors. Karim et al reported

that the presence of sound significantly improved walking ability when sight was limited. This proves that noise enhances walking ability in time-interrupted conditions<sup>[25]</sup>. Palm et al indicate that visual information improves posture stability. In the 75-80 dB auditory information, the postural control is not deteriorated without visual input, but maintains postural stability<sup>[26]</sup>.

## Conclusion

The purpose of this study was to investigate the effect of muscle activity on the gait during gait with respect to noise and visual acuity in healthy adults. When the walking time was not blocked, the TA muscle activity was improved compared to when the time was blocked. Noise was not significantly different in the four muscles during walking. In conclusion, the condition that does not block the visual acuity during walking will help to activate the anterior tibialis anterior muscles. The results of this study showed that muscle activity was not related to noise. Rather, it showed that muscle activation was decreased when the eyes were blocked. Therefore, it is recommended to use visual factor rather than auditory factor for muscle activation.

**Ethical Clearance:** Not required

**Source of Funding:** Self

**Conflict of Interest:** Nil

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