J. Phys. Ther. Sci.
25: 1483–1484, 2013

The Effects of Different Gait Speeds and Lower Arm Weight on the Activities of the Latissimus Dorsi, Gluteus Medius, and Gluteus Maximus Muscles

Tae-young Kim[1)], Won-gyu Yoo[2)*], Duk-hyun An[2)], Jae-seop Oh[2)], Seung-je Shin[1)]

[1)] *Department of Physical Therapy, Graduate School, Inje University, Republic of Korea*
[2)] *Department of Physical Therapy, College of Biomedical Science and Engineering, Inje University: 607 Obangdong, Gimhae, Gyeongsangnam-do 621-749, Republic of Korea*

Abstract. [Purpose] This study researched the effects of different gait speeds and lower arm weight on the activities of the latissimus dorsi, gluteus medius, and gluteus maximus muscles. [Subjects] Fourteen healthy adult men participated in this study. [Methods] All the participants carried out walking on a treadmill at speeds of 3.5 km/h and 5.5 km/h for half a minute. During treadmill gait, electromyographic activity muscle was measured of the latissimus dorsi, gluteus medius and gluteus maximus. [Result] There were significant differences in the muscle activities due to changes in gait speed and lower arm load in the latissimus dorsi and gluteus maximus, but there were no significant differences in the muscle activities of the gluteus medius. [Conclusion] According to our results, arm swing is related to increasing gait speed, and lower arm load is influences the muscle activity of the lower extremities through the posterior oblique sling system.
Key words: Posterior oblique sling system, Arm weight, Arm swing

(This article was submitted May 15, 2013, and was accepted Jun. 20, 2013)

INTRODUCTION

The arm swing of humans during gait is a complex and natural movement of the joints and limbs[1)]. Arm swing during gait minimizes the increase of angular momentum and energy consumption, it has been reported that it also increases stability during gait[2)]. Arm swing was first described as an indirect pendulum movement, which is a form of movement between each joint during gait. Later, however, arm swing was described as being more than just a pendulum movement, rather a direct movement involving muscular action of the shoulders[3)]. Vleeming et al.[4)] suggested that a posterior oblique sling links the hamstring, gluteus maximus, thoracolumbar fascia, and contralateral latissimus dorsi, in sequence. They also reported that the power of the posterior oblique sling muscle is generated from the couple force of both the latissimus dorsi and gluteus maximus, and that these muscles coordinate with each other in direct contraction affecting the stabilization of the sacroiliac joint[5)]. Therefore, the purpose of the present study was to identify the effects of different gait speeds and low arm weight on the activities of the latissimus dorsi, gluteus medius, and gluteus maximus muscles.

*Corresponding author. Won-gyu Yoo (e-mail: won7y@inje.ac.kr)

SUBJECTS AND METHODS

The subjects of this study were 14 young adult males who voluntarily consented to participate in this study and had no disease history or any problem with walking. Their average age, height and weight were 28.57 ± 4.41 years, 174.51 ± 6.62 cm and 73.81 ± 9.14 kg, respectively. Ethical approval was obtained from Inje University Faculty of Health Science Human Ethics Committee, and the subjects provided their written informed consent to participation prior to the commencement of the study. Surface EMG was used to collect raw EMG data using a Trigno wireless system (Delsys, Boston, MA, USA). The sampling rate of the EMG signal was 2,000 HZ, and data was filtered using a band-pass of 20–450 Hz. The root mean square (RMS) was calculated. Three surface electrodes were placed on the following muscles; the latissimus dorsi (lateral to the T9 spinous process over the muscle belly) on the left side, the gluteus medius (proximaly one third of the distance between the iliac crest and greater trochanter) on the right side, gluteus maximus (at the midpoint of a line running from the last sacral vertebrae to the greater trochanter) on the right side. The skin was prepared before attaching the electrodes by shaving the area, and cleaning with 70% isopropyl alcohol to reduce the skin impedance. EMG data were normalized using the maximum voluntary isometric contraction (MVIC) of each muscle, as measured by the manual muscle test[6)]. Each MVIC maneuver was performed of 5 seconds and the average muscle activity for the middle 3 seconds of three trials was used for normalization. All participants walked at speeds of 3.5 km/h and 5.5 km/h, with and without an

Table 1. Comparison of the muscle activities of the different gait speeds with and without the arm weight (Unit: %MVIC)

	No weight		Arm weight	
Gait speed	3.5 km/h	5.5 km/h	3.5 km/h	5.5 km/h
LD	11.3 ± 6.9[a]	15.3 ± 10.3*	12.3 ± 7.7*	16.4 ± 10.4**
Gmed	25.2 ± 11.0	26.6 ± 13.2	25.7 ± 11.9	27.0 ± 12.6
Gmax	19.3 ± 7.7	21.0 ± 8.3*	19.6 ± 7.5	21.6 ± 8.3**

LD, latissimus dorsi; Gmed, gluteus medius; Gmax, gluteus maximus

arm weight on a treadmill for half a minute (2 × 2 design). A 1 kg sand weight was used for the arm weight (Sammons Preston: USA). The EMG signal was collected for 30 seconds, and the first and last 5 seconds were discarded. During data collection, the subjects walked barefoot. The SPSS ver.20.0 (IBM, Armonk, NY, USA) statistical package was used for statistical analyses. Repeated two-way ANOVA was used to investigate differences in muscle activities related to gait speed and the arm weight. Bonferroni's correction for multiple comparison was used to investigate the differences between two-way ANOVA. Significance was accepted for values of $p<0.05$.

RESULTS

There were significant differences in the latissimus dorsi and gluteus maximus muscle activities with change in gait speed and carrying of the arm weight ($p<0.05$), but there were no significant differences in the muscle activities of the gluteus medius ($p>0.05$) (Table 1).

DISCUSSION

The present study investigated how muscle activities of the latissimus dorsi, gluteus maximus, and gluteus medius are changed by different walking speeds and lower arm load during treadmill gait .According to the results of the present study, at different gait speeds, there were significant differences in the muscle activities of the latissimus dorsi and gluteus maximus, and there were also significant differences in the presence of lower arm load. In general, change of gait speed occurs as passive arm swing changes into an active one[7]. Perry et al.[1] also suggested that the angle of arm swing increases as the gait speed increases. Ford et al.[8] suggested that rotation of the trunk and pelvis decreases when the arm swing is limited, and that the gait speed increases due to increased cooperation between the upper and lower extremities when there is no limitation. Consequently, change of angle of arm swing, due to increase in speed, affects the activity of the latissimus dorsi, which belongs to the posterior oblique sling system, during gait. This means that the role of arm swing during gait can affect the movement of the legs, and it is consistent with the results of the present study which suggest that muscle activity of the legs is affected by arm swing increases. Lee et al.[9] reported that there was a more significant difference in gait speed, cadence and stride on the affected side when a load of 1 kg was attached to the wrist than with no load or with load of 1.8 kg attached to the wrist. Cavagnagh et al.[10] suggested that the load of the arms plays an important role in arm swing during gait, and that it represents changes in muscle activity which link the arms to the legs. In the present study, we demonstrated that there are some changes in muscle activities during gait induced by different arm loads. This means that as gait speed increased, gait and the lower arm were affected through the latissimus dorsi and gluteus maximus which belong to the posterior oblique sling system. It also means that load on the arms plays a role in resistance to increased muscle activity of arm swing regardless of gait speed. Therefore, approaches utilizing walking speed and lower arm load during gait could provide therapeutic methods influencing the muscle activities of the legs and trunk stability through the posterior oblique sling system.

ACKNOWLEDGEMENT

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (No. 2012R1A1B4001058).

REFERENCES

1) Perry J: Gait analysis normal and pathological function. Thorofare: Slack, 1992.
2) Collins SH, Adamczyk PG, Kuo AD, et al.: A simple method for calibrating force plates and force treadmills using instrumented pole. Gait Posture, 2009, 29: 59–64. [Medline] [CrossRef]
3) Elftman H: The function of the arms in walking. Hum Biol, 1939, 11: 529–535.
4) Vleeming A, Pool-Goudzwaard AL, Stoeckart R, et al.: The posterior layer of the thoracolumbar fascia: its function in load transfer from spine to legs. Spine, 1995, 20: 753–758. [Medline] [CrossRef]
5) Vleeming A, Mooney V, Snijder C, et al.: Second Interdisciplinary World Congress on Low Back Pain: The Integration Function of the Lumbar Spine and Sacroiliac Joint. San Diego, 1995, pp 149–168.
6) Kendall FP, McCreary EK, Provance PG, et al.: Muscle testing and function with posture and pain, 5th ed. Baltimore: Lippincott Williams & Wilkins, 2005.
7) van Emmerik RE, Wagennar RC: Effects of walking velocity on relative phase dynamics in the trunk in human walking. J Biomech, 1996, 29: 1175–1184. [Medline] [CrossRef]
8) Ford MP, Wagenaar RC, Newell KM: Arm constraint and walking in healthy adults. Gait Posture, 2007, 26: 135–141. [Medline] [CrossRef]
9) Lee K, Kim T, Yoo W: Effect of added mass to wrist on gait parameters in stroke patients. J Phys Ther Sci, 2012, 24: 1161–1162. [CrossRef]
10) Cavanagh PR: The biomechanics of lower extremity action in distance running. Foot Ankle, 1987, 7: 197–217. [Medline] [CrossRef]