Surface slope enhances anterior muscles fatigue in lower limb

Behzad Yasrebi[1], Karim Leilnahari[2], Seyed Esmaeel Hashemi-Aghdam[3], Mir Hamid Salehian[4]

1.Department of Biomedical Engineering, Tabriz Branch, Islamic Azad University, Tabriz, Iran
2.Department of Biomechanics, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran
3.Tabriz University of Medical Sciences, Treatment Affair, Tabriz, Iran
4.Department of Physical Education, Tabriz Branch, Islamic Azad University, Tabriz, Iran
Email: mebyas@yahoo.com Tel: +989144171933
Email: k.leilnahari@gmail.com Tel: +989121770408
Email: mh_salehian@yahoo.com Tel: +989144174072
Email: mehratab@yahoo.com Tel: +989143010357

Abstract: In this human study, the effect of slopes changes of motion surface on four muscles fatigue of lower limb was investigated by surface electromyography. Zero, 10 and 20 degree slopes of a treadmill with constant speed of 5 km/h were used. Seven mature men were selected. Each man as walked on the treadmill at each slope for five minutes time. Then, muscles signals were recorded before and after walking on treadmill by surface electromyography. Time period of between tests for each person on different slopes of treadmill was 48 hours. It was revealed that between fatigue rate of muscles, at zero degree slope, was not significantly different ($P>0.05$). But, at 10 degree slope, between fatigue rate of Tibialis and others was significantly different ($P<0.05$) and was increased. Also, at 20 degree slope, between fatigue rate of Quadriceps and others was significantly different ($P<0.05$) and was increased too. It is concluded that slope changes of motion surface can increase anterior muscles fatigue of lower limb.

[Behzad Yasrebi, Karim Leilnahari, Seyed Esmaeel Hashemi-Aghdam, Mir Hamid Salehian. **Surface slope enhances anterior muscles fatigue in lower limb.** *Life Sci J* 2012;9(4):1410-1412] (ISSN:1097-8135). http://www.lifesciencesite.com. 214

Keywords: muscle, fatigue, electromyography, lower limb, slope

1. Introduction

Muscles activity has potentially important effects on the muscles fatigue. The results of human studies, suggest that after continuous contractions of less than ultimate limit in Quadriceps, forces generated by electrical stimulation in low frequencies were decreased that, it was determined fatigue with low frequency (Moxham et al., 1982). In affects of excessive practice on electromyography signal, concluded that average of fatigue rate was 8.6% and there was not significantly different in EMG amplitude and achieved significantly decrease in average of power frequency at more than 30 seconds range (Huner et al., 2003). Increase of muscles fatigue shift spectral model to low frequency (Sadoyama et al., 1981). Thus far, the effect of slope changes of motion surface on muscles fatigue of lower limb is not clear. Therefore, the results of the effect of muscles activity in cases reported in the literature regarding muscles fatigue may not be directly applicable to slope changes of motion surface. In this study, we investigated the effect of different slopes of motion surface on the muscles fatigue of lower limb.

2. Methods

Seven mature men, ageing 20-23 years old, height 170-180 cm and weighting 65-75 kg were chosen. In this study, selected muscles were Tibialis, Gastrocnemius, Quadriceps and Hamstring. The same athletic shoes for tests were used for all men (Roy et al., 2010; Kumer et al. 2003). Thus, two surface leads were used for each connection so as the distance between metal ports of leads was 2 cm. Before tests, ventricular location of each muscle was accorded to anatomical surface for each man. Then, the desired parts of ventricular muscles was completely shaved and cleaned by alcohol. Before and after tests, weight, height, blood pressure and body temperature of all men was recorded. It was emphasized that the men have not been any sport activity before the tests. Also, before starting the test, each man was seated on a chair to relax for five minutes. A standard wireless EMG system (Bluemyo, Germany) was used to record signals. EMG system's specifications were set to 8 input channels, input signal rate of ±5 V, channel amplification of 0.4- 50 v/v, sampling frequency of 1000 Hz per channel and wireless interface of Bluetooth class II. After the treadmill speed was

fixed on 5 km/h and the leads were connected to EMG, the first, each man was walked four steps and was stood in still position on the ground. Thus, muscles signals were recorded and saved. These signals were known as primary signals to muscles in rest position without fatigue. Then, each man was started walking on the treadmill at zero degree slope for five minutes. After that, immediately, the person was walked four steps and was stood in still position on the ground. Thus, muscles signals were recorded and saved. The same trend for each person at 10 and 20 degree slopes were repeated. Time period of between tests for each person on different slopes of treadmill was 48 hours. Obtained signals with 1000 Hz frequency were recorded and seventy Butterworth filter was used for removing noise from signals. In this research, mean frequency was used to display muscles fatigue (Xu et al., 1998). Mean value and standard deviation of measured mean frequency were computed in each slopes. Paired-samples T- test was performed to compare the means of the outcome measures in rest and stress position (SPSS, Ver. 18).

3. Results

The results showed that the anterior muscles were fatigued compared with the posterior muscles of lower limb. Statistical analysis on mean of mean frequency in Gastrocnemius and Hamstring showed that, between before and after walking on treadmill were not statistically different at different slopes ($P>0.05$). However, Difference between before and after walking treadmill in Quadriceps at zero and 10 degree slopes were not significant ($P>0.05$), but, at 20 degree slope was significant and decreased ($P<0.05$). However, no significant difference were found between before and after walking on treadmill in Tibialis at zero and 20 degree slopes ($P>0.05$), but, at 10 degree slope was significant and decreased ($P<0.05$). These data are presented in figure. The positive effect of slope on rate of fatigue in lower limb muscles at motion on treadmill was shown. This was concluded based on the results from an experimental study on human model. The effect of motion on muscles fatigue has long been under investigation. Motion and exercise cause muscles fatigue from different ways such as summation of Lactate and decreasing blood oxygen rate (Dengler et al., 1998). In EMG studies, muscles fatigue has shown by mean frequency of recorded signals (Hangbo et al., 2003). However, in these researches, the relation between slope of motion surface and muscle fatigue was not showed. In this study, results revealed that, mean of mean frequency decrease in anterior muscles of lower limb by increasing slope. But, the outcome decrease in Quadriceps at 20 degree slope and in Tibials at 10 degree slope and rise to significant differences between before and after walking on treadmill. Thus, we may conclude that, slope increases, increase fatigue rates in anterior muscles of lower limb. This may indicate that, at 10 degree slope, Tibialis does much more contraction, to do heel strike of stance phase. Also, at 20 degree slope, person bends his trunk forward for balance. So, it change body center of gravity site and it cause to change the path of force transmission from lower limb. At this time, Quadriceps endures much more pressure. Thus, it causes Quadriceps fatigue. The results of this study revealed a considerable effect of different slope on muscles fatigue by surface electromyography on human model. Similar positive effects have been reported in the literature at different position. The results from a study on males muscle fatigue in middle-distance running showed the fatigue measured by EMG, at maximal effort both pre and post time trial is more related to sprint performance than endurance performance (Nummela et al., 2009). Furthermore, ITO Akihiko et al., showed to increase muscles fatigue in lower limb during running by electromyography and suggested relation between running figure and muscles fatigue (Akihiko et al., 2003).

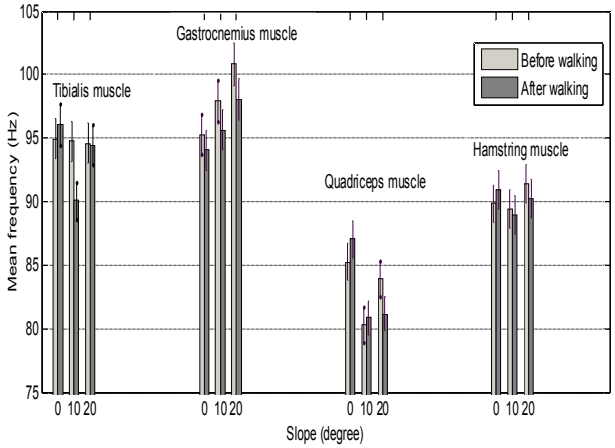

Figure: Mean and Standard deviation of mean frequency in before and after walking on treadmill at zero, 10 and 20 degree slopes in Tibialis, Gastrocnemius, Quadriceps and Hamstring muscles

4. Discussions

The effect of slope of surface on the lower limb muscles fatigue in human model was studied. It was found that slope changes can enhance fatigue rates in anterior muscles of lower limb and also, surface electromyography can record it.

References

1. Akihiko, I.T.O. (2003). Assessment of muscle fatigue of lower extremity during running using EMG online analysis. *J-EAST*. 2003, 143-146.
2. Dengler, R., (1996). Muscle fatigue lactate and pyruvate in mitochondrial myopathy with progressive external. *Muscle Nerve*, 1, 456-462.
3. Hangbo, X., (2006). Mean frequency derived via Hibert-Huang transform with application to fatigue EMG signal analysis. Comprehensive method & Program in Biomed, 82, 114-120.
4. Huner, A.H., (2003). Effect of supramaximal exercise on the electromyographic signals. *British Sport Medicine*. 37, 296-299.
5. Kumer, D.K., (2003). Wavelet analysis of surface electromyography to determine muscle fatigue. *IEEE Trans Nearal System Rehabilitation Eng*. 11, 400-406.
6. Moxham, J., (1982). Changes in EMG power spectrum (high-lower ratio) with force fatigue in humans. *Journal of Applied Physiology*. 53, 1094-1099.
7. Nummela, A., (2003). Muscle fatigue in middle-distance running. *IAAF*. 6.
8. Roy, T.H., (2010). Motion control shoe delays fatigue of shank muscles in runners with over promoting feet. *American Journal of Sport Medicine*. 38, 485-489.
9. Sadoyama, T., (1981). Frequency analysis of surface EMG to evaluation of muscle fatigue. *European Journal of Applied Occupational Physiology*, 47: 239-246.
10. Xu, L.X., (1998). Effects of firing statistics on the mean frequency of EMG and VMG signals. *Bioelectromagnetism*, 2.

9/6/2012