World Applied Sciences Journal 13 (3): 552-557, 2011
ISSN 1818-4952

Comparison of Some Electromyographic Parameters During Treadmill Running in Runners and Non-Athletes

[1]*Solmaz Shirpour Bonab,* [2]*Bahman Tarverdizadeh,*
[3]*Mohammad Ali Azarbayjani and* [4]*Yaghob Salek Zamani*

[1]Physical Education, Islamic Azad University, Central Tehran Branch, Iran
[2]Department of Physical Education and Sport Science, Islamic Azad University, Boshehr Branch, Iran
[3]Department of Physical Education and Sport Science, Islamic Azad University, Central Tehran Branch, Iran
[4]Assistant Professor in Rehabilitation and Physical Medicine-Tabriz Medical University, Iran

Abstract: Objective of this study was to compare some parameters on electromyography during treadmill running in runners and non-athletes. The preliminary assessment show any meaningful difference in morphology of athlete and non-athlete groups (p>0/05). results revealed any meaningful difference between amount of activity, ratio time to reach the peak, the rate of increase and decrease the speed of muscle activity vastus medials in athlete and non-athlete(p>0/05). Similarly, there is no difference between activity rate and increase muscle activity of Gastrocnemius in athlete and other groups. However the average time to reach peak muscle activity GCS in athletic group was significantly higher than non-athlete group (p<0/05). Also reduce the speed of neural activity in the GCS muscle in athletes groups was significantly higher than non-athlete groups (p<0/05). Generally, this study showed that electromyographic variables are not different in running with speed 6 km between athletes and non-athletes. But in athletes, the ratio time to reach the peak the total time activity and reduced speed of neural activity in GCS muscle is more. Results of the research support to hypothesis of the effect of sports participation on neuromuscular function, but is seems that in low work load Compatibility of electromyography, be less observed.

Key words: Electromyography (EMG) · Running · Athlete · Non-athletes

INTRODUCTION

Recent researches around the world have shown that physical activities cause physiological consistency in long term. It is obvious that physical activities have several physiological and mental advantages. The influence of physical activities on treatment, prevention and control of many cardiovascular, neurotic and metabolic diseases has long been important for sports medicine experts. Especially nowadays that inactive life has substituted the active life, physical activities have gained attention.

When talking about sports and physical activities, we remember the role of muscles and muscle contractions as the motion producers. Therefore, studying physiological consistency resulted from work pressure and doing sports, has got many experts' attention. It has long been believed that doing sports and the pressure resulting from that effects the texture and structure of the muscles. Many factors are involved in this regard. Hormone regulation and sports are among the factors that influence the structure and texture skeleton muscles. In fact, the consistency between nerves and muscles in body activities has been the topic of many researches in sports physiology in past decades. Since work is the result of the force applied on bones, it is natural that we experience the maximum physical influence on muscles [1].

It is usually expected that the consistency responses of the muscles to body activities are relied on texture changes. However, experiments show that the maximum power efficiency increases regardless of changes in physical and biochemical characteristics of the muscles. This stage of the responses is called nerophysiological adaption (consistency) that manifests in the first stages of exercising plans in which the muscle power increases significantly. It is believed that it is impossible to contract the muscles before warm up. However after 6 to 8 weeks of practicing and before any changes in shape of the

Corresponding Author: Solmaz Shirpour Bonab, Physical Education, Islamic Azad University, Central Tehran Branch, Iran.

muscle, the activity and therefore the power of the muscle is increased. This phenomenon is related to central nerve system. Overall, there are two ways to increase muscle power via adapting effects of central nerve system. First, during the maximum contraction, some units are used that have never been used before practicing and or in non-athletic subjects. Therefore, practicing is the only way through which recalling and applying big and high tension motion units are easier. Second, it is possible that electrical stimulation pattern in motion units are changed, which is possible either through the increase in motion neurons discharge frequency or through harmonic activities among different units. Muscle-nerve connection, in response to the change in activity level of nerve-muscle, shows significant structural and physiological formability. Studies have proven that the increase in neurotic and muscular activities in endurance and power exercises cause morphological and physiological changes in neurotic and muscular connections.

In recent years, several studies have investigated the effects of different body activities on muscle electrical activities and neurotic-muscular adaption [2-5]. Neurotic-muscular adaption and electrical activities of nerves and muscles are investigated through electromyography (EMG). The main aim of this method is to record electrical activities that are created in motor neurons and muscular fibers. EMG is done by two methods including superficial and deep or needle methods. The superficial method is recommended for investigating whole muscle activities and has been used in several investigations. Judge, Mureau and Burke (2003) have investigated the neurotic muscular adaptors in professional athletes doing endurance exercises. In this study, 14 track and field athletes from different categories participated in a 16-week practice plan. The results showed that the practice period resulted in the increase in EMG amplitude and its activation level, which shows the improvement in neurotic muscular pattern of the subjects [6].

Jaeger *et al.,* (2003) investigated the differences among elite hockey players and normal people's hamstring muscle contraction pattern. 16 healthy and normal subjects as well as 16 elite hockey players participated in this investigation. The results of the study showed that the contraction threshold of EMG activity of Hamstring muscles is significantly higher in elite players [7].

Sbriccoli *et al.,* (2010) investigated neurotic muscular response in knee muscles during isometric contractions and kicks in professional and amateur karate players. The results showed that professional players show a special strategy in neurotic muscular activation. It seems that the pattern depends on the exercise type and level. According to statistics related to time, elite players had more ability to use their muscles quickly that seems to be related to neurotic muscular adaption [8].

Jurimae *et al.,* (2007) investigated the EMG threshold in four lower part muscles and compared them in aviation threshold. 49 subjects with the average age of 23.8 from different athletic fields participated in this study. The results showed that there are meaningful differences in different athletic fields [9].

Rainoldi *et al.,* studied electromyographic responses of vestus medial and biomechanical changes in endurance and power athletes. 12 endurance athletes and 6 power athletes performed the isokinetic movement of knees to their fatigue threshold. The results showed that the power athletes are able to do voluntary contraction more than normal subjects could. However no meaningful difference in their EMG activity could be found [10].

According to the abovementioned points, in order to better understanding about the effects of long term involvement in sports, some electromyographic variables of the Gastrocnemius and vastus medial muscles in athletes and non athlete subjects while running were investigated in this study.

MATERIALS AND METHODS

This study is fundamental in its goal and causative-comparative in its approach. 9 runners (with the age of 23.44 +/-4.3, 70.33 +/-9.30 kg, 172.77+/-6.35 cm, body mass index 23.5 +/-2.46 kg/m2) as the athletic group and 8 men (23.5 +/-4.10, 70.18+/-6.95kg, 173.75+/-4.68cm, 23.22+/-1.85kg/m2) as non athletic group participated in this study. Athletic participants were chosen among the track and field athletes participating in practice plans of track and field committee of East Azerbaijan province. Non-athletic subjects were chosen among Tabriz University students. All participants gave written testimonial after being alerted about the aims, stages and details of the study. According to the participants' claims, none of them felt pain or damage in their muscles or lower body parts. Also while controlling the taken drugs, no drugs were found with the side effect on neurotic muscular activities during the study time. In order to investigate the liability of the measurements and executive considerations, the experiments were repeated for five times. During this investigation, the trials were done with complete resting time. The resulted high cohesion factor showed a significant liability. Therefore, the two groups completed the measurements related to electromyographic factors separately between the hours 14:00 and 16:00. Then, the next morning between 10 and 12 the measurements related to body composition were done.

In order to gather the personal information, the special disease background, drug taking background, pain and aches background and muscle damage, a survey was used.

For this purpose the Zeus device model number 9.9+ made in Swiss was used to analyze the body composition. The parameters used from the analysis of this device include age related to body, body mass, fat mass, fat percentage, body mass index, right leg muscle mass, right leg fat mass, basic metabolism, total energy consumption, protein, minerals and body water.

For muscles electromyography, electromyography device with the brand of Biometric Datalog made in England was used. In order to start the measurement protocol, the participant warmed up for five minutes under a standard plan with the appropriate clothe for electrodes (sports shorts). Then, they were asked to sit on a chair to get ready for the electrode connections. The electromyography experts have suggested that it is necessary to grind the dead cells of the area after cleaning the skin with alcohol. After the skin is pulled or the body part is moved, its voltage will change. Erosion of the skin or the hole in dead cells reduces the level of this voltage [11]. Therefore after shaving, the skin on the vastus medials and Gastrocnemius was cleaned with a piece of clothed soaked with alcohol. Then the electrolyte gel was applied on the electrodes and the area. After placing the electrodes, first, the needed specifications were entered into the device. After that, the participant was asked to stand on the treadmill with the brand of Fit made in China and start to run. The speed was at first set to walking speed and was stabled on 6 km/h. after becoming stable, the information related to myographic characteristics of the muscles were recorded for 10 seconds. The running rate reduced gradually and ended. The room temperature was kept constant in order to prevent it from affecting the variables. It almost took for each participant about 7 and 3 minutes to set the electrodes and to measure, respectively. Biometric LTD Datalog was used to measure the parameters. Data were analyzed using SPSS and T-student statistical test and Shapiro ilk and levene (to assess the data to be normal and variance interfere).

RESULTS

Table 1, shows the average, standard deviation and meaningfulness level calculated for muscle activity, the time to reach the peak, increase rate and decrease rate for vastus medials according to athletic and non athletic groups. Table 2, shows the descriptive statistics related to electromyographic characteristics of Gastrocnemius according to athletic and non athletic groups.

No significant relationship was found between muscle activity, time to reach the peak, increase rate from the beginning to the peak and decrease rate from the peak to the end in both groups in vastus medials.

No significant differences were found between the activity level and the increase rate from beginning to peak of Gastrocnemius of both groups.

There was a meaningful difference between the time to reach the peak of athletes and non athletes as well as active time of them. This means that the average peak time of Gastrocnemius in athletes happens 0.081 units later that non athletes. There was also a meaningful difference between athletes and non athletes decrease rate which means that the average of decrease rate of neurotic activity of Gastrocnemius in athletes is 2.65 mw more than non athletes.

Table 1: Descriptive statistics related to electromyographic characteristics of vastus medials

		Statistical parameters	
characteristic	group	M±SD	P value
Muscle activity level (%)	athlete	54.82±0.97	16.05
	Non athlete	55.06±10.83	
Time needed to reach the peak (%)	athlete	0.42±0.46	10.83
	Non athlete	0.34±0.21	
Activity increase rate (miliwolt/second)	athlete	6.54±0.85	12.45
	Non athlete	5.54±8.51	
Activity decrease rate (miliwolt/second)	athlete	6.36±0.10	8.1
	Non athlete	1.39±1.27	

Table 2: Descriptive statistics related to electromyographic characteristics of Gastrocnemius

		Statistical parameters	
characteristic	group	M±SD	P value
Muscle activity level (%)	athlete	52.45±17.38	0.93
	Non athlete	53.07±9.33	
Time needed to reach the peak (%)	athlete	0.61±0.15	0.03
	Non athlete	0.42±0.18	
Activity increase rate (miliwolt/second)	athlete	4.86±4.85	0.128
	Non athlete	2.03±1.04	
Activity decrease rate (miliwolt/second)	athlete	8.53±7.38	0.02
	Non athlete	1.75±1.18	

DISCUSSION AND CONCLUSION

The present study aims to compare some electromyographic parameters in vastus medials and Gastrocnemius of athletes and non athletes while running.

In table 1, standard deviation and meaningfulness level is calculated for muscle activity level, the time to reach the peak, activity increase rate and activity decrease rate are shown for the two mentioned groups. The results about the vastus medials show that activity level in one step, the time to reach the peak relative to total time, activity increase rate and activity decrease rate show no meaningful difference in two groups.

Also in table 2, descriptive statistics related to electromyographic characteristics of Gastrocnemius are shown for both groups. The results of the study showed that no meaningful difference can be found between the activity level and increase rate of the abovementioned muscle in both groups. The lack of difference in electromyographic parameters between athletes and non athletes was consistent with the findings of Jurimae *et al*., however it is not in agreement with the findings of Jaeger *et al.* [7], Sbriccoli *et al.* [8], Ahmadizad [12] and Oliveira and Gonjalves *et al.* [13].

Also the evidence from semi experimental investigations on the effects of exercising on electromyographic parameters is comparable with the findings of the present study. The studies by Hakinen *et al.* [4], Hakinnen [5], Judge *et al.* [6], The Paut-Mathieu *et al.* [14], Shakeri [15], Lephart *et al.* [16] and Mikkola *et al.* [17] have shown that by practice interventions, electromyographic activity level of the target muscle has significant increase that is not in agreement with the present study on vastus medials. However thvastus medialse studies by Weir *et al.* [18] and Eyvazi [19] support the findings of the present study.

Several factors are involved in this disagreement. It seems that the difference in experimental activities is an important factor in this regard. Most of the investigations have used the maximum voluntary contractions that might have effect on the electromyographic activity level of muscles during the data records. It means that one is able to increase their recalling rate of motor units and therefore their muscular activities. On the other hand, the chosen activity was running with the speed of 6 km per hour that perhaps wasn't long enough for the person to complete recall motor units. Also, the diversity in the used muscles can be another factor in the disagreements in the investigations because muscles are different in their fast and slow contractions. Therefore because of the different patterns of recalling of the muscles, it is possible for different muscles to show a different electromyographic pattern in response to a specific force. Also, the possible differences in involvement rate of athletic subjects and body activity level of non athletic subjects can be other important factors in this regard.

In another part of the investigation, the comparison in electromyographic characteristics of the Gastrocnemius showed that time to reach the peak of this muscle in athletes is significantly more than in non athletes. This means that for athletes Gastrocnemius reaches its peak slower than the other group. Also, the decrease rate of neurotic activity of Gastrocnemius in athletes is significantly higher than in the other group which shows that Gastrocnemius in athletes loses its electromyographic activity very fast in spite of longer peak time. These findings show that in running cycle, athletes have more time to gain power from their Gastrocnemius muscle in order to push their body forward. Therefore they can take off faster. It seems that this activation pattern in athletes is related to their running pattern. This description is supported by mentioning that the sports category chosen is track and field. Similar results were found in the study by Tillin *et al.* [20]. They compared the muscular neurotic performance of explosive power of athletes and non athletes. They measured the electromechanical delay as well as explosive power and force improvement in four stages. The results of the study showed that the athletes had more neurotic activation and force improvement in the one third of their muscle activation. However non athletes showed more EMG changes in the second one third of the force improvement.

The difference in EMG activity is not in agreement with the findings of the present study and it is possible that the mentioned difference is related to the maximum test to record the data. But, the difference in time and electromyography of athletes and non athletes is in agreement with the findings of the present study about Gastrocnemius.

Also, the difference in time electromyographic pattern of the muscles in the study of Vitasalo *et al.* [21] has been reported. They investigated the neurotic muscular performance of jumping athletes and tested the active subjects in their skills at drop jumping in two different heights of 40 and 80 centimeters respectively. The results of their study showed that the electromyographic activity of the muscles of their legs in the stage before the activity in athletes starts before non athletes. This causes a better result for the jumpers of triple jumping in their jumping level. According to these, it seems that the strategies related to muscle activation are relied on athletic activities. In other words, doing sports will increase the harmony in muscular-neurotic performance in order to do motion skills more efficiently. Therefore, the findings of the present study support the hypothesis of the influence of sports involvement on muscular neurotic performance. On the other hand, it seems that while comparing electromyographic adaptations of athletes and non athletes, distinguishing the differences between them is difficult in low load periods. It means that the lack of difference in some electromyographic characteristics between the two groups of athletes and non athletes can be described with the specified low load period (running with the speed of 6km per hour). The experimental findings in this regard also show that electromyographic activity patterns will change with the speed [22].

Many researches relate muscular performance to neurotic factors directly and to hypertrophic factors indirectly [4,23,24]. According to the primary assessments that showed there is no significant difference between morphology of athletes and non athletes, it seems that some of the electromyographic differences are because of the differences in neurotic factors between the two groups. In general, the present study showed that when there is no meaningful difference in the morphology of athletes and non athletes, electromyographic parameters of Gastrocnemius when running with the speed of 6 km per hour are not different. However, the ratio of reaching the peak to the total activity time as well as decrease rate in athletes is more than in non athletes.

REFERENCES

1. Sanadgol, H., 2000. Sport physiology. 1st Ed. Iranian national committee publication, pp: 101-124.
2. Hakkinen, K., A. Pakarinen, H. Kyrolainen, S. Cheng, D.H. Kim and P.V. Komi, 1990. Neuromuscular adaptations and serum hormones in females during prolonged power training. Int. J. Sport Med., 11(2): 91-8.
3. Carolan, B. and E. Cafareli, 1992. Adaptations in co activation after isometric resistance training. J. Appl. Physiol., 73(3): 911-17.
4. Hakkinen, K., A. Pakarinen and M. Kallinen, 1992. Neuromuscular adaptations and serum hormones in women during short term intensive strength training. Eur. J. Appl. Physiol., 64(2): 106-110.
5. Hakkinen, K. and A. Kekkonen, 1995. Neuromuscular adaptations during intensive strength training in middle-aged and elderly males and females. Electromyography Clin. Neurophysiol., 35(3): 137-47.
6. Judge, L.W., C. Moreau and J.R. Burke, 2003. Neural adaptations with sport-specific resistance training in highly skilled athletes. J. Sports Sci., 21(5): 419-27.
7. Jaeger, M., J. Freiwald, M. Engelhardt and V. Lange-Berlin, 2003. Differences in hamstring muscle stretching of elite field hockey players and normal subjects. Sportverletzung-Sportschaden, 17(2): 65-70.
8. Sbriccoli, P., V. Camomilla, A. Di Mario, F. Quinzi, F. Figura and F. Felici, 2010. Neuromuscular control adaptations in elite athletes: the case of top level karateka. Eur. J. Appl. Physiol., 108: 1269-80.
9. Jürimäe, J., S. Von Duvillard, J. Mäestu, A. Cicchella, P. Purge, S. Ruosi, T. Jürimäe and J. Hamra, 2007. Aerobic-anaerobic transition intensity measured via EMG signals in athletes with different physical activity patterns. European J. Appl. Physiol., 101(3): 341-47.

10. Rainoldi, A., M. Gazzoni, R. Merletti and M.A. Minetto, 2008. Mechanical and EMG responses of the vastus lateralis and changes in biochemical variables to isokinetic exercise in endurance and power athletes. J. Sports Sci., 26(3): 321-31.
11. Merletti, R. and P. Parker, 2004. Electromyography: physiology, engineering and noninvasive applicationsý. Hoboken, NJ: IEEE/John Wiley and Sons.
12. Ahmadizad, S., 2000. Comparing electro-neurography and electromyography parameters in athletes and non athletes. Thesis from Tehran University, pp: 55-60.
13. Oliveira, A.S.C. and M. Gonçalves, 2009. Leg muscles recruitment pattern in soccer players and active individuals during isometric contractions. Electromyography and Clin. Neurophysiol., 49(2-3): 93-101.
14. Thepaut-Mathieu, C.V., J. Hoecke and B. Maton, 1988. Myoelectrical and mechanical changes linked to length specificity during isometric training. J. Appl. Physiol., 64(4): 1500-5.
15. Shakeri, H., 2000. Study the effect of unilateral quadriceps muscle strengthening on bilateral muscle activity based on electromyography idea. Thesis in rehabilitation of Iran University.
16. Lephart, S.M., J.P. Abt, C.M. Ferris, T.C. Sell, T. Nagai, J.B. Myers and J.J. Irrgang, 2005. Neuromuscular and biomechanical characteristic changes in high school athletes: a plyometric versus basic resistance program. British J. Sports Med., 39(12): 932-38.
17. Mikkola, J., H. Rusko, A. Nummela, L. Paavolainen and K. Häkkinen, 2007. Concurrent endurance and explosive type strength training increases activation and fast force production of leg extensor muscles in endurance athletes. J. Strength and Conditioning Res., 21(2): 613-21.
18. Weir, J.P., T.J. Housh, L.L. Weir and G.O. Johnson, 1995. Effects of unilateral and isometric strength training on joint angle specificity cross training. Eur. J. Appl. Physiol., 70(4): 337-43.
19. Eivazi, M.A., 2001. Study the effect of biceps muscle eccentric and concentric strengthening on surface electromyographycal parameters, thesis in tarbiat modarres university.
20. Tillin, N.A., P. Jimenez-Reyes, M.T.G. Pain and J.P. Folland, 2010. Neuromuscular performance of explosive power athletes versus untrained individuals. Med. Sci. Sports and Exercise, 42(4): 781-91.
21. Viitasalo, J.T., A. Salo and J. Lahtinen, 1998. Neuromuscular functioning of athletes and non-athletes in the drop jump. European J. Appl. Physiol. Occupational Physiol., 78(5): 432-40.
22. Gazendam, M.G.J. and A.L. Hof, 2007. Averaged EMG profiles in jogging and running at different speeds. Gait and Posture, 25(4): 604-14.
23. Hakkinen, K. and P.V. Komi, 1983. Electromyographic changes during strength training and determining. Med. Sci. Sports Exercise, 15(6): 455-60.
24. Vecchio, F., C.D. Percio, N. Marzano, *et al.,* 2008. Functional cortico-muscular coupling during upright standing in athletes and nonathletes: a coherence electroencephalographic-electromyographic study. Behavioral Neuroscience, 122(4): 917-27.