Indian J Physiol Pharmacol 1998; 42 (3) : 369–374

EFFECT OF ACUTE EXERCISE ON SKIN POTENTIAL IN SEDENTARIES AND TRAINED ATHLETES

UGUR TARIK TURACLAR*, SENA ERDAL,
ABDULLAH ARSLAN AND AHMET YILDIZ

Department of Physiology,
Cumhuriyet University,
Faculty of Medicine,
58140, Sivas, Turkey

(Received on August 18, 1997)

Abstract : Endosomatic electrodermal activity (skin potential level and skin potential response) as an indirect indicator of sympathetic nervous system activity was measured in 35 sedentary male students and 22 trained athletes of two groups during resting and after an acute exercise. The aim of this study was to investigate the difference of skin potential parameters between sedentaries and trained athletes before and after the acute exercise in bicycle ergometer.

In sedentaries' group while skin potential level (SPL) and latency showed no significant variations, skin potential response (SPR) decreased significantly after the exercise ($P < 0.001$). In athletes' group SPL increased ($P<0.01$) and SPR decreased ($P<0.05$) after the exercise but latency had no significant difference. In addition, athletes had significantly higher SPL and lower SPR values before and after the exercise comparing with the sedentaries.

The increase of SPL in athletes' group was thought to depend on sweat duct pores which have been more active and open than sedentaries. Also the decrease in SPR in athletes' group was thought to depend on the lower sweating threshold in athletes.

Key words : acute exercise; sympathetic activity; electrodermal activity; skin potential

INTRODUCTION

The phenomenon of electrodermal activity (EDA) which is accepted as an indirect indicator of the sympathetic nervous system, is produced principally by the activity of the eccrine sweat glands, since the sweat glands are innervated by the sympathetic sudorific nerve fibers. Thus, in all types of stimulations and reflex conditions, which rises the sympathetic tonus and sympathetic sudorific activity, the parameters of EDA are seem to be changed (1, 2).

In order to learn the reactivity of sympathetic nervous system EDA is widely used as a measurement system for recording

*Corresponding Author

the electrical activity of the skin and its changes. As sympathetic nerve fibers' tonic activity and the barrier layer of the skin are forming the basal (tonic) level of EDA, increased discharges of sympathetic sudorific fibers (as a result of sympathetic nervous system activation) produce the phasic changes of EDA (3, 4).

Skin potential response, skin resistance response and skin conductance response, the three of the parameters of EDA, are formed as a response of deep inspiration, emotional stimulations like excitement and mental stress, sensorial stimulations like hot or cold, noise, pain the electrical stimulus.

The activity of the eccrine sweat glands plays the most important role in the formation of phasic electrical activity of the skin (5). Eccrine sweat glands exist mostly in palmar and plantar regions of the body. Eccrine glands are also innervated by sympathetic sudorific nerve fibers like all other types of the sweat glands.

We couldn't find any literature that is related with the relationship between the skin potential parameters, which is one of the active electrical characteristics of the skin, and acute exercise in sedentaries and in the trained athletes.

The purpose of this study was to investigate the effect of acute exercise on the skin potential parameters (SPL, SPR and latency) in sedentaries and in the trained athletes.

METHODS

The sedentaries' group of the study consisted of 35 volunteer male, healthy, non-smoker medical students, aged between 18-24 (mean 21.03 ± 0.29) years. The trained athletes' group consisted of 22 volunteer male, healthy, non-smoker athletes, aged between 18–26 (mean 21.86 ± 0.56) years and most of them were the students of Sports Academy.

In both groups, before and after the acute exercise, skin potential records were taken from the right arm in a supine position at normal room temperature (20.0 ± 2°C) in a quiet place under dim light within a Faraday cage with sound insulation. Unpolarized Ag/AgCl electrodes were attached to the hypothenar blister of the hand and 2/3 upper portion of the inside of the forearm (6, 7). The electrodes are fixed after the inside of the forearm was cleaned with a piece of cotton, dipped in alcohol, and then the skin resistance was reduced by removing the stratum corneum by the use of a fine sandpaper. In this manner, the connection part of the inactive reference electrode was determined. For the amplification, Nihon Kohden's AA-600 H model was used and the records were kept in DC mode.

For the electrical stimulation of the ulnar nerve silver EEG electrodes (inner caliber: 9 mm) were used. Square wave single shock impulses (duration: 1200 µs, strength: 5 mA) were applied on each volunteer (8). Nihon Kohden Ag/AgCl electrodes with inner caliber of 7 mm were used as the skin potential recording electrodes.

After connecting the electrodes to the volunteers, they were informed about the experimental conditions and ten minutes were allowed for their adaptations to these conditions as well as their skins' adaptation to the electrode system. SPL was evaluated as the amplitude of quietness just before the electrical stimulus. The value of SPR was evaluated as the arithmetical mean of response potentials which occurred after three electrical stimuli in each session. The amplitude of skin potential response was measured peak to peak in milivolts (mV) (9). Latency was evaluated as the time between the artifact of stimulus and the beginning of SPR in seconds.

The exercise was made in one step. After making a very light (~15 Watts for 30 seconds) exercise in order to warm up, the subjects were told to be increased the level to 60 rpm for 3 minutes. The value of exercise loading made by Monark 814 E bicycle ergometer was 150 Watts.

The significance of the difference between the average measurement values of the sedentaries' group and the trained athletes' group were compared by the application of the significance test of the difference between the two averages of the independent groups (Student 't' test).

RESULTS

1. Pre-exercise results

The mean values and the statistical comparisons relating to SPL, SPR and the latency obtained from the two groups are given in Table I.

The average SPL values of the trained athletes' group were significantly higher than the values of the sedentaries' group ($P<0.01$) (Fig. 1). In sedentaries' group SPR amplitudes were greater than of the

TABLE I : The comparison of the sedentaries' and the trained athletes' groups before the exercise.

	SPL(mV)	*SPR(mV)*	*Latency(s)*
Sedentaries' Group	47.37 ± 1.30	10.49 ± 1.02	2.69 ± 0.15
T. Athletes' Group	58.86 ± 4.12	5.41 ± 0.70	2.62 ± 0.13
	$F=9.992$ $P<0.01$	$F=13.008$ $P<0.01$	$F=0.087$ $P>0.05$

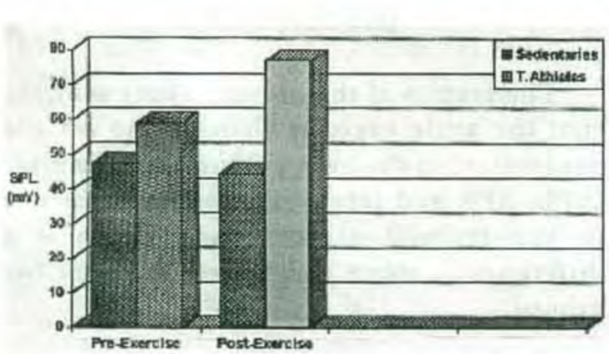

Fig. 1 : The comparison of SPL values of the sedentaries' and the trained athletes' groups before and after the exercise.

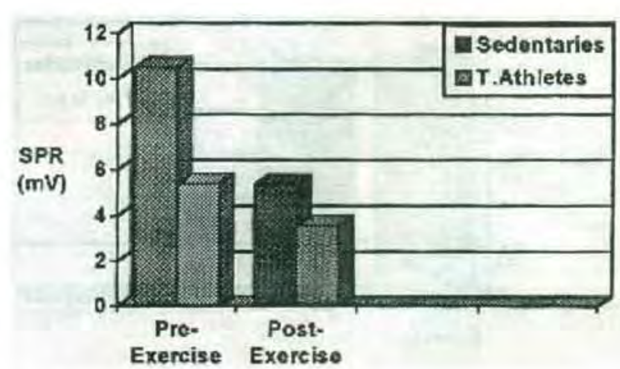

Fig. 2 : The comparison of SPR amplitudes of the sedentaries' and the trained athletes' groups before and after the exercise.

TABLE II : The comparison of the sedentaries' and the trained athletes' groups after the exercise.

	SPL(mV)	*SPR(mV)*	*Latency(s)*
Sedentaries' Group	44.40 ± 1.29	5.37 ± 0.55	2.58 ± 0.09
T. Athletes' Group	76.73 ± 4.82	3.59 ± 0.54	2.56 ± 0.08
	F=61.067 P<0.01	F=4.716 P<0.05	F=0.023 P >0.05

athletes' group (P<0.01) (Fig. 2). Although the latency was longer in sedentaries' group, it was statistically insignificant (P>0.05) (Fig. 3).

2. Post-exercise results

The mean values and the statistical comparisons relating to SPL, SPR and latency are given in Table II.

The average SPL values of the trained athletes' group were significantly higher than of the sedentaries' group (P<0.01) (Fig. 1). SPR amplitudes measured in sedentaries' group were higher than of the athletes' group (P<0.05) (Fig. 2). The latency of the sedentaries' group was longer than the other group, but it was statistically insignificant (Fig. 3).

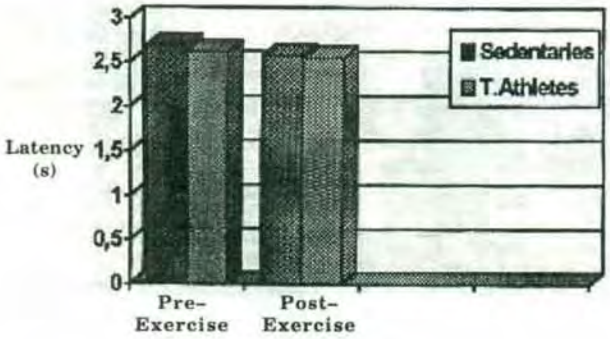

Fig. 3 : The comparison of latency parameter between two groups before and after the exercise.

3. The effect of acute exercise on sedentaries' group

The average pre-exercise SPL values were higher than post-exercise values, but it was insignificant (P>0.05). SPR values obtained before the exercise were higher than post-exercise values (P<0.01). The latency was longer before the exercise but it was insignificant (P>0.05).

4. The effect of acute exercise on trained athletes' group

The average post-exercise SPL values of this group were higher than pre-exercise values (P < 0.01). SPR amplitudes taken after the exercise were greater than pre-exercise amplitudes (P < 0.05). The latency measured before the exercise was longer, but it was insignificant (P > 0.05).

DISCUSSION

The results of the present study indicate that the acute exercise changes the various parameters of the skin potential parameters (SPL, SPR and latency) in sedentaries and in the trained athletes and there is a difference in these parameters between two groups.

In the athletes' group, the mean SPL values being higher after the exercise can be explained as the increased sympathetic sudorific activity and so increased function of the sweat glands (10, 11). Besides this, the decrease of SPR amplitude after the exercise can be correlated with 'the law of initial values' (12). According to this law; the higher basal level of a parameter, the lower value of the response of this parameter produced by a stimulus. Consequently, the increased values of SPL after the exercise is thought to be the reason of the decreased SPR. Another reason of the SPR decrease can be decrease of the resistance or increase of the conductance as a result of sweating in the region of skin between the two electrodes (13).

In sedentaries' group because of the different factors, such as high sweating threshold, the pores of the sweat ducts probably which are not completely open, reduced sympathetic activity in the reasons of the body which do not participate in the exercise actively post-exercise SPL values didn't change statistically (14, 15). The cause of decrease in SPR after the exercise can be decrease of skin resistance or increase of the skin conductance.

In the comparison of the SPL values, both before and after the exercise, between the two groups, it was seen that the trained athletes' group had higher SPL values. This finding is in parallel with those of Myrtek et al. According to Myrtek, in type A people who have higher sympathetic activation skin conductance level (SCL) is higher than type B people (16). It is known that skin conductance and skin potential are opposite parameters of EDA. When the skin conductance level reduces, skin potential increases (17).

Various investigations have shown that regular exercise decreases the sweating threshold, so in trained athletes sweat gland function and consequently sweating is expected to be increased (18, 19). In this respect, in our study, higher levels of SPL in athletes, before and after the exercise, is thought to depend on low sweating threshold, and so increased electrical activity of the sweat ducts filled with sweat.

Similarly, the low amplitude of SPR in athletes group can be explained as a result of increased function of sweat glands, reduced sweating threshold and so reduced skin resistance (13, 20).

Our results seem to correlate with Palmar sweat index (PSI) (21). According to PSI, the higher function of a sweat gland is, the higher value of PSI. The number of the active sweat ducts' pores is the factor affecting the value of PSI. It is known that regular exercise increases PSI (22). Therefore, we are of the opinion that the number of the active sweat duct pores are much more in trained athletes than sedentaries. So, higher values of PSI may be an other cause of SPL increase in trained athletes' group.

There was no significant difference between two groups in latency before and after the exercise. In addition, in every group the latency periods were found to be shortened after the exercise but this was statistically insignificant.

In conclusion, we have observed significant differences between trained athletes and sedentaries in skin potential parameters. Comparing with the sedentaries' group higher SPL and lower SPR of the athletes' group is thought to depend on increased vagal tone because of training (23).

The results of the present study shows that in people who have increased vagal tone as a result of exercise skin potential parameters can be used to determine the change in autonomic nervous system.

REFERENCES

1. Venables PH. Electrodermal activity. *Annals New York Academy of Sciences* 1991; 620P: 192–207.
2. Christie MJ. Electrodermal activity in the 1980s: a review. *Journal of the Royal Society of Medicine* 1981; 74: 616–622.
3. Christie MJ, Venables PH. Effects on 'basal' skin potential level of varying the concentration of an external electrolyte. *Journal of Psychosomatic Research* 1971; 15: 343–348.
4. Uncini A, Pullman SC. The sympathetic skin response: normal values, elucidation of afferent components and application limits. *Journal of the Neurological Sciences* 1988; 87: 299–306.
5. Mahon ML, Iacono WG. Another look at the relationship of electrodermal activity to electrode contact area. *Psychophysiology* 1987; 24(2): 216–222.
6. Scarba Scerbo A, Weinstock Freedman L. A major effect of recording site on measurement of electrodermal activity. *Psychophysiology* 1992; 29(2): 241–246.
7. Martinez-Selva JM, Roman F. Sex differences and the asymmetry of specific and non-specific electodermal responses. *International Journal of Psychophysiology* 1987; 5: 155–160.
8. Fujii M, Yamada T. The effects of stimulus rates upon median, ulnar and radial nerve somatosensory evoked potentials. *Electroencephalography and Clinical Neurophysiology* 1994; 92: 518–526.
9. Naveteur J, Sequeira-Martinho H. Reliability of bilateral differences in electrodermal activity. *Biological Psychology* 1990; 31: 47–56.
10. Christensen NJ, Galbo H. Sympathetic nervous activity during exercise. *Annals Review of Physiology* 1983; 45: 139–153.
11. La Rovere MT, Mortara A. Autonomic nervous system adaptations to short-term exercise training. *Chest* 1992; 101(5): 299S–303S.
12. Germana J. Rate of habituation and the law of initial values. *Psychophysiology* 1968; 5(1): 31–36.
13. Edelberg R. The effects of initial levels of sweat duct filling and skin hydration on electrodermal response amplitude. *Psychophysiology* 1983; 20(5): 550–557.
14. Tam HS, Darling RC. Sweating response: a means of evaluating the set point theory during exercise. *Journal of Applied Physiology* 1978; 45(3): 451–458.
15. Saito M, Tsukanaka A. Muscle sympathetic nerve responses to graded leg cycling. *Journal of Applied Physiology* 1993; 75(2): 663–667.
16. Myrtek M, Greenlee MW. Psychophysiology of type A behaviour pattern: a critical analysis. *Journal of Psychosomatic Research* 1984; 28(6): 455–466.
17. Fredrikson M. Effects of autogenic training on cardiovascular and electrodermal reactivity to mental stress: an exploratory study. *Journal of Psychophysiology* 1990; 4: 289–294.
18. Roberts MF, Wenger CB. Skin blood flow and sweating changes following exercise training and heat acclimation. *Journal of Applied Physiology* 1977; 43(1): 133–137.
19. Henane R, Flandrois R. Increase in sweating sensitivity by endurance conditioning in man. *Journal of Applied Physiology* 1977; 43(5): 822–828.
20. Nadel ER, Pandolf KB. Mechanisms of thermal acclimation to exercise and heat. *Journal of Applied Physiology* 1974; 37(4): 515–520.
21. Freedman LW, Scarba Scerbo A. The relationship of sweat gland count to electrodermal activity. *Psychophysiology* 1994; 31: 196–200.
22. Kohler T, Weber T. The behaviour of the PSI (Palmar sweat index) during two stressful laboratory situations. *Journal of Psychophysiology* 1990; 4: 281–287.
23. Prokop L. Einfuhrung in die Sportmedizin, 3. *Auflage. Stutgart, Gustav Fischer,* 1983.