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The Effect of Acute Exercise on Skin Potential in Trained Athletes

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Abstract: Endosomatic electrodermal activity (skin potential level, skin potential response and latency) as an indirect indicator of sympathetic nervous system activity was measured in 22 trained athletes during resting and after acute exercise. The aim of this study was to investigate the difference in skin potential parameters in trained atheletes before and after acute exercise on a bicycle ergometer.

Skin potential level (SPL) increased ($p<0.01$) and SPR decreased ($p<0.05$) after the exercise but latency had no significant difference.

The fact that the mean SPL values were higher after the exercise can be explained by the increased sympathetic sudorific activity and so increased function of the sweat glands. Another reason may be the sweat duct pores which were more active and open after the exercise. Also the decrease in he SPR was thought to depend on the lower sweating thereshold.

Key Words: Acute exercise, electrodermal activity, sympathetic activity.

Introduction

The phenomenon of electrodermal activtiy (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 increase the sympathetic tonus and sympathetic sudorific activity, the parameters of EDA seem to be changed (1, 2).

In order to determine the reactivity of the sympathetic nervous system EDA is widely used as a measurement system for recording 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 in the EDA (3, 4). Skin potential response, skin resistance response and skin conductance response, the three parameters of EDA, are formed as a response to deep inspiration, emotional stimulants like excitement and mental stress, sensorial stimulants like heat or cold, noise, pain and electrical stimulus.

The acitivity 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 the palmar and plantar regions of the body. Eccrine glands are also innervated by sympathetic sudorific nerve fibers like all other types of sweat glands.

We encountered nothing in the literature on the relationship between the skin potential parameters, which are the active electrical charateristics of the skin, and acute exercise in trained athletes.

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

Materials and Methods

22 volunteer male, healthy, non-smoking athletes, aged between 18-26 (mean 21.86±0.56) years were selected from the Sports Academy.

While the pre-exercise skin potential values of the athletes were the control values, the post-exercise values of the same athletes were the experiment values in the statistical analysis.

Table. Effect of exercise on skin potentials in trained athletes.

	SPL(mV)	SPR(mV)	Latency(s)
Pre-Exercise	58.86±4.12	5.41±0.70	2.62±0.13
Post-Exercise	76.73±4.82	3.59±0.54	2.56±0.12
	p<0.01	p<0.05	p>0.05

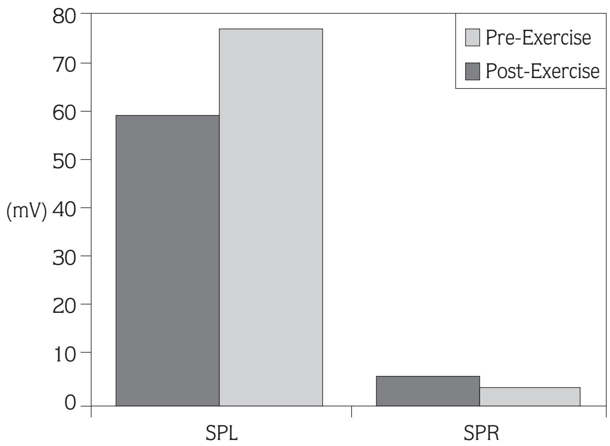

Figure. The comparison of SPL and SPR values of trained athletes before and after exercise.

Before and after the acute execrise, 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 and the upper third of the inside of the forearm (6, 7). The electrodes were fixed after the inside of the forearm had been cleaned with a piece of cotton, dipped in alcohol, and then the skin resistance was reduced by removing the stratum corneum with 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.

In order to prevent the measurements being affected by circadian rhythm variations, all the recordings were made at 10.00-12.00 a.m.

For the electrical stimulation of the ulnar nerve, silver EEG electrodes (inner caliber: 9mm) were used. Square wave single shock impulses (duration: 1200 µs, strength: 5 mA) were applied to each volunteer (8). Nihon Kohden Ag/AgCl electrodes with an inner caliber of 7mm 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 adaptation to these conditions as well as their skins' adaptation on 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 millivolts (mV) (9). Latency was evaluated as the time between the artificat of the stimulus and the beginning of the SPR in seconds.

The exercise protocol was designed as 150 Watts, 60 rpm and 3 minutes in one step with a Monark 814 E bicycle ergometer.

Statistical analysis: While the resting values of SPL, SPR and latency were the control values, post-exercise values were the experiment values. Values were given as mean±standart error of the mean. Differences between the mean values were determined by using student's t test and were considered to be significant at $p<0.05$.

Results

The mean values and the statistical comparisons relating to SPL, SPR and the latency obtained from the athletes are given in the table.

Pre-Exercise Results: The average SPL and SPR were 58.86±4.12 mV and 5.41±0.70 mV respectively. Latency was 2.62±0.13 s.

Post-Exercise Results: While the average SPL and SPR were 76.73±4.82 mV and 3.59±0.54 mV respectively, the latency was 2.56±0.12 s.

The Effect of Acute Exercise

The average post-exercise SPL values were higher than pre-exercise values ($p<0.01$). SPR amplitudes taken after the exercise were greated than pre-exercise amplitudes ($p<0.05$) (Figure). The latency measured before the exercise was longer, but it was insignificant ($p>0.05$).

Discussion

The results of the present study indicate that acute exercise changes the various parameters of the skin potential parameters (SPL, SPR and latency) in trained athletes.

Christensen (1983) and La Rovere (1992) have stated that exercise increases the skin resistance parameters because of increased sympathetic sudorific activity and consequent increased function of the sweat glands (10, 11). In our study, the fact that the mean SPL values were higher after the exercise can be explained by the increased sympathetic sudorific activity and so increased function of the sweat glands. In addition, the decrease in 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, in our study, the increased values of SPL after the exercise are thought to be the reason for the decreased SPR. Another reason for the SPR decrease can be a decrease in the resistance or an increase in the conductance as a result of sweating in the region of skin between the two electrodes (13).

In different investigations carried out by Roberts (14) and Henane (15) exercise was shown to decrease the sweating threshold, so in trained athletes sweat gland function and consequently sweating is expected to be increased. In this respect, in our study, higher levels of SPL in athletes, after exercise, is thought to depend on a low sweating threshold, and so increased electrical activity of the sweat ducts filled with sweat.

Similarly, the lower amplitude of SPR after the exercise can be a result of increased function of the sweat glands, reduced sweating threshold and so reduced skin resistance (13).

Our results seem to correlate with the palmar sweat index (PSI) (16, 17). According to the PSI, the higher function of a sweat gland is, the higher value of the PSI. The number of the active sweat ducts' pores is the factor affecting the value of the PSI. It is known that exercise increases the PSI (17). Therefore, we are of the opinion that in our study the number of active sweat duct pores increased after the exercise. Hence, higher values of the PSI may be another cause of the SPL increase.

The latency period is expected to be shortened after exercise because of the increased sympathetic activity and body temperature. But although the latency periods were found to be shortened after exercise this was statistically insignificant.

In conclusion, we observed significant differences in skin potential parameters before and after exercise. Higher SPL and lower SPR are thought to depend on increased sympathetic activity (10).

Skin resistance and the skin conductance which are the other parameters of EDA are used widely both in sports physiology, neurophysiology and in neurologic patients (8, 10, 11). In the present study, the skin potential parameters are shown to be affected by acute exercise. Therefore, like the other parameters of EDA, skin potential parameters can be used to determine the changes in the autonomic nervous system in clinical and physiologic studies.

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