Effect of Respiratory Sinus Arrhythmia (RSA) Training on Stress Induced by Excessive Exercise

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Abstract. This research is an experimental study on non-equivalent control group for preparing effective intervention for stress induced by exercise. The study analyzed the effect of Respiratory Sinus Arrhythmia (RSA) training on the autonomic nervous system in university student subjects that received stress induced by excessive treadmill running. The subjects were 38 healthy university students, who were allocated based on the results of coin toss to either the experiment group that would receive breathing training or the control group that would not receive the training. Then, stress was induced by using treadmill for 20 minutes after which the experiment group underwent breathing training through the RSA training program as visually presented on the computer monitor while comfortably seated for 10 minutes. The test results showed significantly positive difference in the experimental group for stress index (t=4.98, p=<.001), sympathetic activity (t=3.88, p=.001), and psychological stress (t=6.93, p=<.001). In conclusion, it can be said that RSA training is an effective intervention for reducing stress induced by excessive exercise.

Keywords: Autonomic nervous system, HRV, Respiration, Stress

1 Introduction

Stress refers to certain effect that can bring disorder to natural equilibrium in the body. Personal injury, exposure to foreign object or environment, illness, and emotional or psychological disorder can all bring about state of disorder to equilibrium present in the human body. Because there is close relationship between stress and autonomic nervous system, there are many studies being reported that prove that sympathetic and parasympathetic activities can be good indices for stress response.

There are many factors for inducing stress such as mental and physical factors, and exercise is one of the stress inducers as well. Exercise brings resistance to the human body and stimulation in the respiratory and circulatory system. The demand for oxygen in the body due to highly intense exercise is more than 10 times compared to when stable, because of which the body stress would rapidly increase as well [1].

During the recovery period after exercise, the human body undergoes endless physiological activities in order to stabilize. In particular, heart rate rapidly decreases for 1-3 minutes immediately following exercise and is affected by respiration [2].
Therefore, breathing training can be a very important intervention as a method for recovering athletic performance by reducing stress induced by the athletes’ exercise in sports settings where winning outcome is important or gyms where many intense exercises are taken place. Nonetheless, concrete studies on such issues are still insufficient.

Although there are various methods for relieving stress, this study aims to provide basic data for preparing effective intervention technique for relieving stress from exercise by analyzing how RSA training affects the autonomic nervous system.

2 Tools and Methods

A. Study Subjects

The subjects for this study were 38 healthy students attending "S" University in Seoul who have agreed to participate in the research. The allocation of the subjects to either the experiment group that would receive breathing training or the control group that would not receive such training was based on the results of coin toss.

B. Research Tools

- Respiratory Sinus Arrhythmia (RSA) Training
  
  RSA refers to normal arrhythmia that takes place due to the effect of signals from the sympathetic nerve and vagus nerve that influence the normal sinus [3]. Among the action factors of heart rate variability (HRV), the factor that can most directly and freely be controlled is breathing. Therefore, breathing training by using such technique can bring about balance in the biorhythm with the effect of stress reduction and relaxation.

- Autonomic Nervous System Activity
  
  The voluntary stimulation of the sinoatrial node that causes heartbeat is controlled by the autonomic nervous system. As such, the HRV analysis has high reliability and reproducibility in measuring the autonomic nervous system activity, through which information on the physiological response can quantitatively be obtained [3]. In this study, the autonomic nerve activity is analyzed by recording the electrical activity in the heart as a result of influence of sympathetic and parasympathetic nerves on the sinoatrial node through analyzing the ECG noninvasively with HRV device (SA6000, Medicore, Korea).

- Psychological Stress
  
  In this analysis, the subjects subjectively expressed their emotion after receiving stress induced by treadmill exercise.
C. Procedure

The data was collected from April 1, 2014 to April 30, 2014. Survey including information on sex, age, smoking/non-smoking and drinking/non-drinking was carried out for all subjects and their blood pressure and degree of stress were measured. For the stabilization of the subjects, the test was carried out after the subjects were comfortably seated for about 30 minutes after their arrival.

After the subjects were briefed on the study and completed the agreement forms, they were allowed to rest for 10 minutes while being comfortably seated in a chair after which their pre-test autonomic nervous system activity was measured to check the homogeneity between the groups. Afterwards, the subjects underwent treadmill running for 20 minutes to receive stress based on previous study [4], after which the HRV was measured again.

Then, the experiment group underwent breathing training through the RSA training program as visually presented on the computer monitor for 5 minutes while comfortably seated in a chair. In breathing training, the subjects inhaled when the pump rose and exhaled when the pump lowered 14 times per minute. If the subjects felt burdened or fatigued after breathing training, they were allowed to rest for a little while before continuing. The control group was allowed to rest for 10 minutes in the same posture as the experiment group but without any intervention. After the experiment, their HRV was measured in the same method as the pre-test measurement.

D. Data analysis

IBM SPSS Ver. 21 was used for statistical analysis. The paired t-test was conducted to observe the changes in the pre-stress and post-stress blood pressure, HRV and VAS.

3 Results

After conducting RSA training for stress after excessive exercise, there were significant differences in the experimental group for stress index \( (t=4.98, p<.001) \), sympathetic nerve activity \( (t=3.88, p=.001) \) and psychological stress \( (t=6.93, p<.001) \) <table 1>.

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<thead>
<tr>
<th></th>
<th>Control group (n=17)</th>
<th>Experimental group (n=21)</th>
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<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
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<tr>
<td></td>
<td>M±SD</td>
<td>M±SD</td>
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<tr>
<td>Stress index</td>
<td>224.88±189.11</td>
<td>219.67±231.60</td>
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<tr>
<td>Symathetic nerve</td>
<td>75.02±19.80</td>
<td>75.27±20.09</td>
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Table 1. Comparison for stresses after excessive exercise
4 Discussion

The test results showed that the stress index and sympathetic nerve activity reached their climax after short excessive exercise, which significantly reduced after the RSA training. This is considered to be due to the adjusting physiological functions as the concentration of catecholamine, which is one of the stress hormones, increased. The amount of oxygen consumed during exercise increases in proportion to the intensity of the exercise. Even after the completion of the exercise, the volume of oxygen consumed for unit of time is observed to be higher compared to when stable [4]. Since the stress from bodily fatigue after excessive exercise is fully recovered after 44 minutes has elapsed from the end of exercise [5], fast recovery of the body is an important point of interest in elite athletes that require best athletic performance. When taking a look at another previous study [6], it is reported that excessive exercise acts as stress stimulant wherein excess post-exercise oxygen consumption (EPOC) is related to the changes in the concentration of norepinephrine, which is a sympathetic nerve response hormone, and concentration of blood lactic acid. Therefore, it is considered that the stress was reduced while improving insufficient oxygen intake through the RSA training in this study.

Exercise and breathing are closely related, and breathing control of athletes in sports settings acts as a very important factor for stable exercises to come [2]. Therefore, breathing training on site that immediately relieves unstable respiration of the athletes can be said to be a significant intervention for reducing stress from exercise. As such, additional researches for developing various kinds of intervention techniques for relieving stress from exercise are proposed.

References