

Effects of Wearing a Compression Undershirt during Exercise on the Autonomic Nervous System *

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The purpose of this study is to clarify the effects of wearing a compression undershirt during exercise on the autonomic nervous system. Ten male students at Fukui University of Technology volunteered to be subjects in this study.

The control experiment was done by determining the effect of wearing a compression undershirt on the autonomic nervous system at rest. The actual experiment was done by determining the effects of wearing a compression undershirt while the subjects did push-ups, squats, and a low-intensity exercise.

It was found that by wearing a compression undershirt, the strain degree of the parasympathetic nerve decreases, and the strain degree of the sympathetic nerve increases, more during push-up exercises. A low-intensity exercise increases the strain degree of the sympathetic nerve by wearing a compression undershirt even though the low-intensity exercise stimulates the parasympathetic nerve.

This study was supported by a research grant from Fukui University of Technology and was orally presented in the briefing session of the Special Research Funds in Fukui University of Technology held on March 18, 2020.

Key Words: Wearing Compression Undershirt, Exercise, Autonomic Nervous System

1. Introduction

A large number of compression undershirts have been produced on a commercial basis, and these have been scientifically reported to have healthy effects. Among these effects, there are many personal views and impressions. These effects are suggested to reduce body fat, strengthen muscle, maintain correct posture, among others. Although these healthy effects are scientifically suggested about body composition, Ebisu, et al¹⁾ showed no beneficial effect on body composition from the wearing of compression undershirts. To make this conclusion they determined the variables such as percent body fat (%Fat), body fat (Fat), %Fat and Fat values in right and left legs, feet, arms and hands, lean body mass, muscle mass, body mass index, body weight, blood pressure, and pulse rate during rest and amount of physical activity. Another study²⁾ reported that the wearing of compression tights could help alleviate constipation because the compression tights pressed the abdomen. Some research³⁾ on applying pressure to a muscle such as pressurizing training indicated that it usually leads to muscle hypertrophy and muscle strengthening. Such training is to provide muscle strength training while suppressing the muscles.

It can be thought that pressurization might act to excite the sympathetic nerve which possibly would motivate and lead to an ambitious life and active days. Since squeezing blood vessels causes blood pressure to increase, it

* Received May 29, 2020

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might be dangerous for people with high blood pressure or the elderly. It is, however, beneficial for youth whose blood pressure is not high. The strain of the sympathetic nerve brings a motivation and will, which in turn brings power, spirit, and energy for experiencing life.

Exercises stimulating sympathetic nerve are generally known. If more sympathetic nerves are, however, excited during exercise, the exercise uses more energy, and the exercise is more effective. Not many studies on the effects of wearing compression undershirts, however, have been conducted during exercise. In this study, effects of exercises such as push-ups and squats on the sympathetic nerve were clarified. If exercises such as push-ups and squats are found to stimulate more sympathetic nervous system during exercise by wearing compression undershirts, it can be expected that wearing the undershirt increases the exercise effect. Both push-ups and squats are often performed as training to raise muscular endurance, but this might influence the result as push-ups are training of the upper body, and squats are training of the lower part of the body. The effect of wearing a compression undershirt can be clearer in detail by clarifying the two kinds of characteristic different exercise.

A low-intensity exercise was reported to stimulate the parasympathetic nerves⁴⁾. If the low-intensity exercise simulates the sympathetic nervous system by wearing a compression undershirt, the undershirt will show a big influence on the sympathetic nervous system.

In this way, effects of wearing a compression undershirt during exercise on the autonomic nervous system can be interpreted as effective at stimulating the system and improving the effect of the exercise. Such a research study, however, has not been proved scientifically.

The purpose of this study is, therefore, to clarify the effects of wearing a compression undershirt during exercise on the autonomic nervous system.

2. Methods

Ten male students at Fukui University of Technology volunteered to be subjects in this study. All of the experiments in this study were done in August, 2019. The control experiment was done by determining the effect of wearing a compression undershirt on the autonomic nervous system at rest. The actual experiment was done by determining the effects of wearing a compression undershirt in doing push-ups and squats and a low-intensity exercise.

The following were carefully considered to clarify the effects of wearing a compression undershirt during exercise: (1) Just the upper torso of a short-sleeved compression undershirt was worn to try to ensure the safety of all subjects since it is possible for the pressure to raise blood pressure or to cause discomfort; (2) The subjects' safety was considered paramount, rather than pushing them into more rigorous exercise in the hope of discovering positive effects of the compression undershirt; (3) Subjects were told to stop wearing the compression undershirt whenever they felt pain; (4) Written informed consent was obtained from all of the subjects; and (5) The subjects' safety was, furthermore, enhanced by this study's having been approved by the Officials Standards Committee for Research Conducted with Human Subjects of Fukui University of Technology (人-2019-04).

The variables determined in all of the experiments in this study were the following: Mean HR, Max HR, Mini HR, LF, HF, LF/HF, TP, cvTP and a deviation value. The fatigue stress measuring system (the Fatigue Science Laboratory, VM302) was used to determine the reaction of the autonomic nervous system.

The compression undershirt, by e-GATE, Inc. used in this study is shown in Photo 1. The undershirt is made of 75% nylon and 25% polyurethane. The compression undershirt used in this study presses the abdomen. Although there are many individuals who wear it willingly, the concrete effect is not clarified scientifically.

3. Results and Discussion

A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing at rest is shown in Table 1. Since this was done as a control experiment before the real experiment,

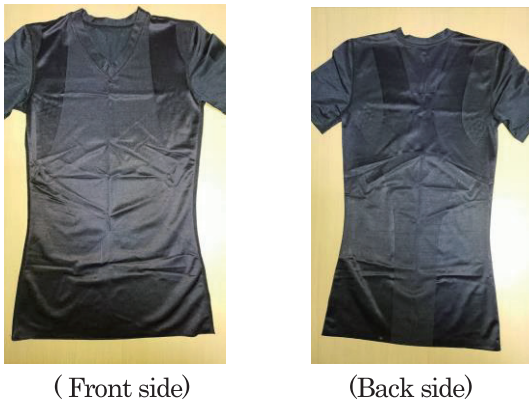


Photo 1. The compression undershirt

Table 1. A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing at rest.

Variables	Non-wearing	Wearing	t
Mean HR (bpm)	66.6 ± 10.7	66.7 ± 10.1	0.092
Max HR (bpm)	77.6 ± 10.7	77.8 ± 10.6	0.108
Min HR (bpm)	58.8 ± 10.9	58.5 ± 10.7	0.226
LF	1089.2 ± 1035.5	1159.5 ± 952.9	0.229
HF	1417.9 ± 1370.6	972.6 ± 944.3	2.492*
LF/HF	3.65 ± 4.68	5.66 ± 9.50	1.135
TP	2506.9 ± 1984.3	2132.3 ± 1521.5	0.884
ccvTP	4.90 ± 1.90	4.69 ± 1.81	0.671
Deviation	49.50 ± 10.28	48.7 ± 9.56	0.605

(Mean ± SD, n = 10)

(* p<0.05)

where: Mean HR = Mean Heart Rate

Max HR = Maximum Heart Rate

Min HR = Minimum Heart Rate

LF = Index Reflecting the Sympathetic Nerve

HF = Index Reflecting the Parasympathetic Nerve

LF/HF = Balance of the Sympathetic Nerve and the Parasympathetic Nerve

TP = Work of the Whole Autonomic Nerve Function

ccvTP = the Value that Corrected TP with a Heart Rate

Deviation = Deviation Value

the table was also illustrated in another research paper⁵⁾. That study and the current study were conducted by using the same subject at a different time of the same day. Mean, standard deviation (SD) and t-ratio values of all variables on the autonomic nervous system at rest between the results of wearing and not wearing the compression undershirts are shown in the table. Subjects in the study sat down on a chair and rested with eyes closed, without wearing a compression undershirt, for 90 seconds. The subject's autonomic nervous system measurements were then taken. Afterwards, the compression undershirt was applied for 90 seconds and measurements were repeated.

According to the Table 1, it was shown that HF significantly decreased by compression undershirt wearing. It seems that wearing a compression undershirt decreases the parasympathetic nerve at rest. Since the

sympathetic nerve and the parasympathetic nerve have opposite work and when sympathetic nerve is tense, the body is in an excited state. Conversely, strain of the parasympathetic nerve means that the body is in a relaxed state. It is, therefore, found that compression undershirt wearing seems to create a tense state.

A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing in performing 12 times of push-ups is illustrated in Table 2. Mean, SD, and t-ratio values of all variables on the autonomic nervous system while doing push-ups between results of not wearing and wearing the compression undershirts are shown in the table. After a subject performed 12 push-ups without the undershirt, they rested for a while afterwards. After having confirmed that blood pressure and pulse rate values came back to the resting period, subjects performed 12 push-ups with the undershirt.

Table 2. A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing in performing 12 times of push-ups.

Variables	Non-wearing	Wearing	t
Mean HR (bpm)	72.7 ± 7.9	71.3 ± 7.5	1.210
Max HR (bpm)	88.9 ± 7.8	85.5 ± 8.3	2.022 [†]
Min HR (bpm)	61.5 ± 6.9	58.3 ± 9.0	0.458
LF	998.8 ± 564.6	2171.3 ± 1915.9	2.099 [†]
HF	1295.2 ± 898.7	1561.7 ± 1547.7	0.597
LF/HF	1.70 ± 1.41	4.10 ± 4.07	1.900 [†]
TP	2293.9 ± 1116.0	3733.1 ± 2672.9	2.014 [†]
ccvTP	5.30 ± 1.40	6.25 ± 2.30	1.917 [†]
Deviation	51.7 ± 7.8	53.8 ± 12.1	0.969
(Mean ± SD, n = 10)			([†] p<0.1)

As illustrated in Table 2, LF, LF/HF, TP, and ccvTP were found to increase by wearing the compression undershirts. On the other hand, max HR decreased.

About the tendency to decrease seen in max HR in Table 2, the reason might be that the subject carried out 12 push-ups at a comfortable pace. The autonomic nervous system was measured at the time of the compression undershirt wearing after confirming that blood pressure and pulse rate values returned to a state equal to the resting period. At the time of the second set of push-ups, the practice and warm-up effect of the first set may have influenced the performance. It might be necessary to do detailed examination before this experiment.

A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing while performing 12 squats is shown in Table 3. Mean, SD, and t-ratio values of all variables on the autonomic nervous system in the squat between results of not wearing and wearing the compression undershirts are illustrated in Table 3. The subjects performed 12 squats with and without compression undershirts, and the reaction of the autonomic nervous system was measured on these occasions. As seen in Table 3, none of the t-ratios showed significant differences. As for the reason why significant difference was not observed, all the subjects belong to the athletic club of Fukui University of Technology, and were well trained. Exercise load was probably low based on their body weight, and the number of repetitions. As described earlier both push-ups and squats are often performed as training to raise muscular endurance, but this might influence the result as push-ups are training of the upper body, and squats are training of the lower part of the body. A more detailed study will be, however, necessary to clarify this.

A change of the autonomic nervous system at the time of the compression undershirt wearing and non-

Table 3. A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing while performing 12 times of squats.

Variables	Non-wearing	Wearing	t
Mean HR (bpm)	66.9 ± 9.8	68.0 ± 10.1	1.072
Max HR (bpm)	84.3 ± 8.9	83.8 ± 9.2	0.321
Min HR (bpm)	57.9 ± 10.0	56.6 ± 8.4	0.477
LF	1905.3 ± 2299.6	1287.1 ± 719.4	1.125
HF	1337.6 ± 1560.3	1571.8 ± 1223.4	0.215
LF/HF	4.52 ± 4.63	2.16 ± 2.07	1.249
TP	2584.5 ± 1872.3	3238.4 ± 3151.4	1.043
ccvTP	5.02 ± 2.06	5.20 ± 2.67	0.403
Deviation	49.1 ± 12.4	48.8 ± 14.6	0.153
(Mean ± SD, n = 10)		(None of the above t-values is significant.)	

wearing in a low-intensity exercise is shown in Table 4. Mean, SD, and t-ratio values of all variables on autonomic nervous system are listed in Table 4. As indicated in the table, TP significantly increases by com-

Table 4. A change of the autonomic nervous system at the time of the compression undershirt wearing and non-wearing in a low-intensity exercise.

Variables	Non-wearing	Wearing	t
Mean HR (bpm)	71.5 ± 14.5	70.8 ± 13.3	0.534
Max HR (bpm)	87.1 ± 16.3	85.4 ± 13.9	0.635
Min HR (bpm)	61.1 ± 13.7	62.1 ± 11.4	0.457
LF	792.2 ± 554.4	968.7 ± 638.0	0.857
HF	753.0 ± 672.7	666.1 ± 733.2	0.544
LF/HF	2.12 ± 1.38	5.20 ± 7.43	1.364
TP	1545.0 ± 1148.5	1634.8 ± 1045.9	4.662**
ccvTP	4.03 ± 1.53	4.13 ± 1.53	0.227
Deviation	45.9 ± 7.7	45.90 ± 9.04	0.000
(Mean ± SD, n = 10)		(** p<0.01)	

pression undershirt wearing during the low-intensity exercise.

With the low-intensity exercise by the bicycle ergometer (with the heart rate of exercise intensity 30 % by the Karvonen's method), parasympathetic nerve activity was detected to be aggravated⁶⁾. Subjects in this study performed a low-intensity exercise, rowing a bicycle ergometer at 30W and 50rpm, at the time of compression undershirt wearing and non-wearing, and the subject measured a strain degree of the autonomic nervous system. The load of the low-intensity exercise of this study was decided in reference to the result and the next findings. A continuous exercise using the whole body as for the exercise strength, 50-80% of the maximum oxygen intake is appropriate⁷⁾. Also exercise by using a bicycle ergometer was selected as aerobic exercise, such as cycling, is effective for stress relaxation⁷⁾.

There is much indication about the relaxation effect by the low-intensity exercise. It is said that β

-endorphin secreted in the brain increases by exercising moderately, and there is painkilling action to this β -endorphin⁸. Also increases in the quantity of secretion of neurotransmitters such as norepinephrine, serotonin, and dopamine seems to help relieve stress⁸. It is thought that a series of results of research revealed that exercise is effective for maintenance improvement of the mental health although there are many questions about the mechanism of the effect expression⁹. Since a low-intensity exercise increases the flexibility of blood vessels¹⁰, low-intensity exercise can be thought to stimulate parasympathetic nerve.

However, it brings the strain of the further sympathetic nerve when a compression undershirt is worn even if it is low-intensity exercise. It is thought that it is effective in bringing promotion of a motivation and will. It seems that wearing a compression undershirt during exercise, however, shows a bigger effect to bring the strain of the sympathetic nerve.

This study was supported by a research grant from Fukui University of Technology and orally presented in the briefing session of Special Research Funds in Fukui University of Technology held on March 18, 2020.

4. Conclusion

The purpose of this study was to clarify the effects of wearing a compression undershirt during exercise on the autonomic nervous system. Ten male students at Fukui University of Technology volunteered to be subjects in this study. The variables determined in all of the experiments in this study were the following: Mean HR, Max HR, Mini HR, LF, HF, LF/HF, TP, ccvTP, and a deviation value.

The control experiment was done by determining the effect of wearing a compression undershirt on the autonomic nervous system at rest. The actual experiment was done by determining the effects of wearing a compression undershirt in the push-up and the squat and a low-intensity exercise.

As results of this study, it was found that by wearing compression undershirt, the strain degree of the parasympathetic nerve decreases and the degree of the sympathetic nerve increases more during push-up exercise. A low-intensity exercise increases the strain degree of the sympathetic nerve by wearing compression undershirt even though the low-intensity exercise is reported to stimulate the parasympathetic nerve.

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(2020 年 9 月 10 日受理)