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Effect of Wearing a Thermal Compression Sleeve on Isokinetic Strength and Muscle Activity of Wrist Flexors and Extensors

Ki Hong Kim*, Hwan Jong Jeong **, Chan Jeong Hong***, Hyun Sung Kim****, Byung Kwan Kim *****
**Associate Professor, Department of Recreation and Leisure Sports, Dankook University, Korea*
bodykim@hanmail.net
***Research Professor, Sports Science Institute, Dankook University, Korea*
ssilverman@naver.com
****Research Professor, Department of Recreation and Leisure Sports, Dankook University, Korea*
mehcj@naver.com
*****President, TTM korea, Korea*
ttm1@ttmkorea.com
******Research Professor, Sports Science Institute, Dankook University, Korea*
kbk5581@naver.com

Abstract

The purpose of this study, the wearing conditions of functional pressure clothing applied with the thermotherapy device were determined by three types (NW, CW, TCW) and the difference in isokinetic strength, muscle activity around the forearm was investigated and the effects of products mixed with thermotherapy and pressure treatment were verified. Ten men in their 20s were selected as subjects, and all subjects were randomly assigned three wearing conditions, and wrist flexion/extension exercise was performed at 30° and 90° angular velocity in isokinetic equipment. Peak torque, average power, and EMG were measured during exercise in all conditions. For peak torque, CW was significantly highest at velocity of 30°/sec flexion. Average power showed no significant difference by condition. In the angular velocity of 90°/sec, flexion was significantly higher in CW and TCW than in NW. As a result, wearing clothes with pressure effect and heat effect can show high efficiency in high muscle strength development and fast contraction activity during low speed exercise, and it is thought that it can show improvement of exercise ability through efficient recruitment of motor unit.

Keywords: *Thermal Compression Sleeve, Isokinetic strength, EMG, Wrist joint*

1. Introduction

As interest in healthy hobby activities increases and the age group enjoying sports and leisure activities gradually becomes more diverse, related industries are continuing to grow. Among them, sports functional wear products have received great response from consumers with various ergonomic functional designs, and

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Corresponding Author: kbk5581@naver.com
Tel ***-****-****
Research Professor, Sports Science Institute, Dankook University, Cheonan, South Korea

over the past decade, pressure clothing has been one of the hot topics in sportswear[1, 2] .

Compression clothing worn during games to improve athletic performance continues to increase in popularity among athletes, and it is known that there are more than 100 types of products as a result[3]. The pressure caused by elastic force of clothing is reported to contribute to the performance of exercise through improvement of blood flow and removal of metabolic products[4], changes in kinematic parameters[1], improvement of muscle function and proprioception[5], and improvement of muscle accuracy and efficiency through control of soft tissue vibration[6].

The recently developed functional clothing, TTM (Korea), is a product that combines pressure clothing and thermal treatment devices, and has the advantage of applying both elastic pressure and thermotherapy to local areas at the same time. Heat treatment is a method of applying heat to a specific area[7, 8], which is known to increase metabolism in the body, induce vascular dilatation in the muscles, and reduce blood viscosity, thereby smoothing blood flow[9]. In addition, it was reported that the increase in local muscle temperature increases the speed of cross-bridge cycling and increases the ATP utilization[10, 11], which increases the efficiency when performing high-intensity exercise[12].

However, the evidence of the performance benefits related to the exercise performance of compression garments is still limited[13], and most of the previous studies investigated products applied to the thigh and calf, and studies investigating products applied to the upper extremities is non-existent[14].

In fact, although warm-up exercises are being implemented as a general practice before training or compet ition, there are few studies that investigate muscle contraction due to changes in muscle temperature due to w arm treatment[12], and it is generally limited to exercise-induced body temperature increase effect.

In this study, the wearing conditions of functional pressure clothing applied with the thermotherapy device were determined by three types (NW, Compression-wearing: CW, Thermal compression-wearing: TCW) an d the difference in muscle activity around the forearm was investigated and the effects of products mixed wit h thermotherapy and pressure treatment were verified.

2. Experiment Materials and Methods

2.1 Subject

The study was conducted on 10 healthy men in their 20s who were attending C city D university. The researcher fully explained the significance, purpose and procedure of the study to the subjects, and selected only the subjects who voluntarily signed their own autographs in the consent for participation in the study while they were fully aware of the contents of this study. In order to obtain accurate research results, before the experiment, moderate or higher physical activity was refrained from smoking and drinking.

2.2 Study Design

This study was conducted at the Sports Science Research Institute of D University in C. All three wearing conditions(NW: Non-wearing, CW: Compression-wearing, TCW: Thermal compression-wearing) were randomly cross-assigned to all subjects and the wrist flexion/extension exercise was performed at 30° and 90° angular velocity in isokinetic devices every week. In all conditions, EMG of the wrist flexor/extensor muscle was measured during exercise to analyze muscle activity for each condition.

Figure 1. Wearing electrode, thermal compression sleeve and measuring isokinetic muscle strength

2.3 Isokinetic Exercise

Biodex system 4 (Biodex, USA) was used to exercise for isokinetic muscle contraction. To adapt the device to the wrist joint movement environment, Dynamometer 0˚, Dynamometer Tilt 0˚, Seat Orientation 0˚, Seatback Tilt 85˚ were set, and then the wrist attachment and limb-support pad were connected. Then, the subject was seated in a chair and adjusted to 90˚ of the Elbow Flexion, and the axis of rotation was adjusted to the center of the radiocarpal joint. The angular velocity for generating the maximum muscle contraction of the wrist joint was determined as 30° and 90° with reference to Reichard et al (2010) and Harbo et al (2012), and repeated 3 times.

2.4 EMG Measurement

In order to investigate muscle activity in the maximum number of muscle contractions (MVIC) before and after exercise, 4-channel electromyogram (Korean, Laxtha) was used and the surface electrode was attached to wrist flexor and extensor. Wrist flexor was placed on the upper part of the medial epicondyle as far as five fingers, and wrist extensor was placed on the lateral epicondyle as far as four fingers. When attaching the electrodes, two were attached each to the site 1 cm apart from the insertion site of the intramuscular electrode. It was monitored by designating the channel of the muscle at the electrode attachment site in the EMG program.

2.5 Statistical Analysis

For data processing measured in this experiment, the mean and standard deviation of all variables were calculated using the IBM SPSS Statistics (ver 22.0) statistical program. All variables were analyzed by repeated measurement one-way ANOVA method. In case of significant difference, post-hoc was conducted by using LSD method. Statistical significance level was set to =.05.

3. Result

3.1 Difference of peak torque

For peak torque, CW was significantly highest at velocity of 30°/sec flexion. There CW was no significant difference in extension, but showed the highest trend. There was no significant difference in velocity of 90°/sec, but TCW showed the highest trend in flexion. The results of repeated measurement one-way ANOVA analysis for peak torque are as shown in Table 1 and Figure 2.

Table 1. Difference of peak torque(Nm)

Action	Angle	①Non-wearing	②Compression -wearing	③Thermal compression -wearing	F	*p*	Post-hoc
Flexion	30°	18.14±3.73	20.26±3.63	18.06±4.13	20.290	.000	①<②>③
	90°	16.56±6.96	17.26±2.68	18.46±3.45	1.574	.234	
Extension	30°	8.80±0.86	9.84±0.68	9.52±1.46	3.267	.062	
	90°	9.12±2.26	9.10±0.29	8.48±1.33	.600	.560	

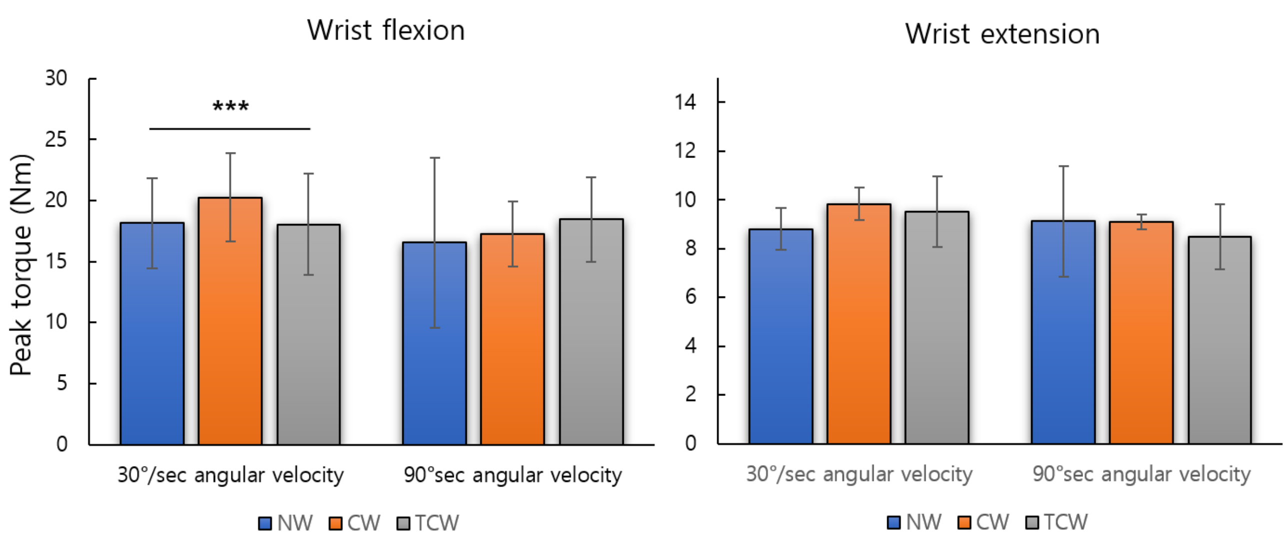

Figure 2. Difference of peak torque

3.2 Difference of average power

Average power showed no significant difference by condition. During isokinetic exercise with an angular velocity of 30°/sec, the average power of the flexor/extensor muscles showed the highest trend in CW. During constant velocity motion with an angular velocity of 90°/sec, the average power showed the highest trend in TCW. The results of repeated measurement one-way ANOVA analysis for average power are as shown in Table 2.

Table 2. Difference of average power(W)

Action	Angle	①Non-wearing	②Compression -wearing	③Thermal compression -wearing	F	*p*
Flexion	30°	7.86±5.95	8.52±3.42	5.10±1.28	2.234	.136
	90°	11.84±6.01	13.58±5.39	16.34±3.50	3.439	.054
Extension	30°	4.26±2.51	4.48±2.30	3.22±0.56	1.165	.334
	90°	6.32±1.14	6.90±1.98	7.72±1.45	1.836	.188

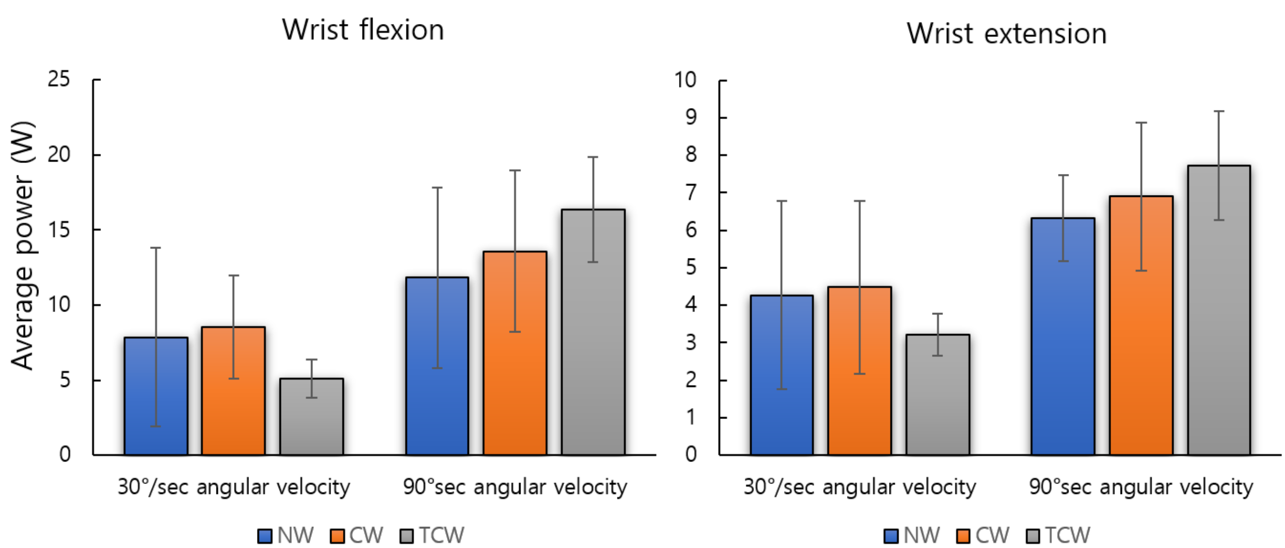

Figure 3. Difference of average power

3.3 Difference of muscle activity

There was no significant difference between EMG of flexor and extensor muscles during the isokinetic exercise with an angular velocity of 30°/sec. In the angular velocity of 90°/sec, flexion was significantly higher in CW and TCW than in NW. There was no significant difference in extensor muscle, but TCW showed the highest trend in flexion. The results of repeated measurement one-way ANOVA analysis for muscle activity are as shown in Table 3.

Table 3. Difference of muscle activity (μV)

Action	Angle	①Non-wearing	②Compression -wearing	③Thermal compression -wearing	F	*p*	Post-hoc
Flexion	30°	148.69±41.30	162.32±34.38	151.53±33.23	.518	.604	
	90°	136.20±38.96	179.79±9.39	159.87±23.10	6.605	.007	①<②③
Extension	30°	114.25±19.39	121.83±25.32	129.29±27.82	2.304	.129	
	90°	108.22±27.17	109.98±21.76	113.96±20.73	.564	.579	

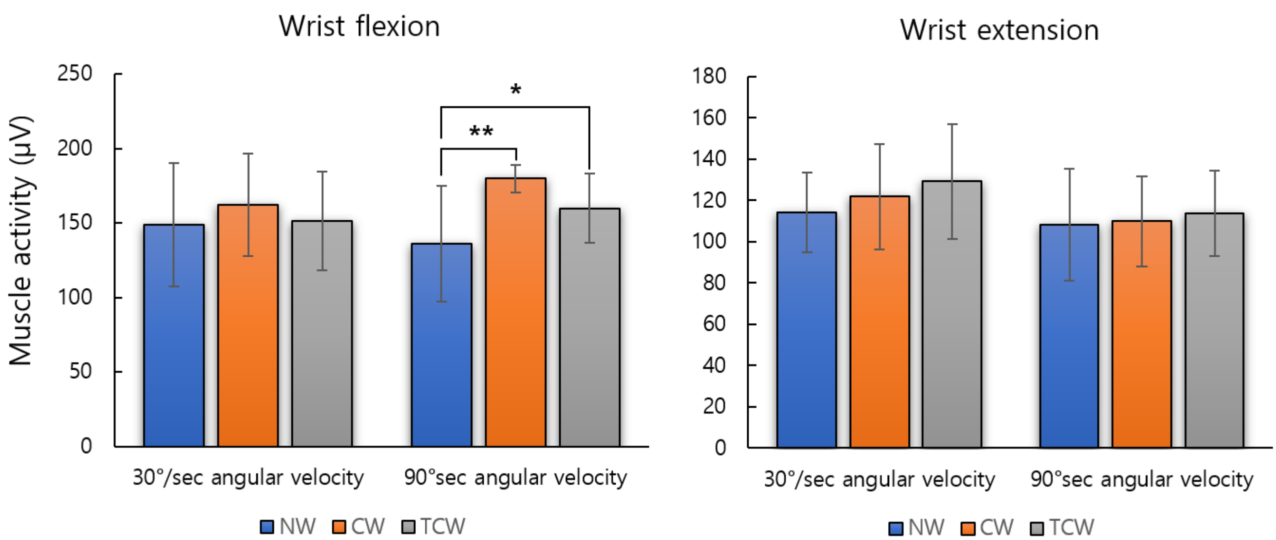

Figure 4. Difference of muscle activity

4. Discussion

Functional compression garments are attracting attention from athletes and sportsmen with the expectation that they will have a positive effect on athletic performance. It is expected that exercise efficiency will increase due to elastic support and amplified proprioceptive feedback[1, 15], and thermal treatment is known to be an important determinant of ATP consumption[11] and maximal strength expression[16] of skeletal muscle.

Peak torque means the highest torque value among isokinetic muscle strength measurements and is used as an index for strength evaluation[17]. For peak torque by condition, CW was significantly high only at 30° angular velocity during flexion operation, and although there was no significant difference in extension, CW showed the highest tendency. On the other hand, there was no clear trend at 90° angular velocity. The clear difference at 30° angular velocity suggests that the effect of pressure can occur when the muscle fo rce is maximized, which can improve the mechanical efficiency of the muscle[18] due to the compression clo thing and improve the proprioception[19].

In the study of Doan et al[1] and Sperlich et al[20], it has been suggested that pressure can provide mechanic al advantages in alleviating muscle vibration, responding to fatigue, and lowering perceived efforts in force-b ased activities such as power sprinting and jumping.

Average power is a time-divided value that expresses how quickly muscle power can be produced and shows the ability of muscle groups to act for a fixed time, so it has a high correlation with the power that requires a lot of muscle power expression in a short time[21]. In this study, Average power did not show any significant difference by all conditions. This result is consistent with the study of Pérez-Soriano et al[22], which reported that the effect of pressure clothing on power improvement is still unclear, although it can help to express muscle strength.
On the other hand, the high average power of TCW at 90° angle could be related to the increase of ATPase a ctivity due to heating. According to previous studies, the higher the muscle temperature from 22.5 ℃ to 38.6 ℃ in human isometric contraction, the higher the ATP utilization, which could increase the cross-bridge cyc le speed[10, 11].
In addition, as the temperature in the muscle increases, the energy cost decreases and the efficiency of exerci se increases in the fast muscle contraction activity[12], so it is thought that it is higher at 90° angle speed fast er than 30° angle speed.
iEMG reflects the amount of motor units mobilized as an indicator of muscle activity. During flexion operation, CW and TCW were significantly higher at 90˚ angular velocity, and CW and TCW tended to appear higher in all conditions. It is believed that high muscle activity occurred at the time of maximal force expression due to the stabilization of the joint due to compression[23], and the optimization of nerve transmission and muscle mechanics due to improvement of proprioception[5].
Søgaard et al[24] has suggested that external pressure can optimize mechanomyographic transmission to the skin from the inside and molecular dynamics, and Doan et al[1] supports this study, and that compression clo thing can improve motor ability due to the efficient mobilization of exercise units rather than the increase of muscle strength expression of the muscle fiber itself.

5. Conclusion

For the purpose of verifying the ergogenic effect of the thermal compression sleeve, this study comparatively analyzed peak torque, average power, and muscle activity during wrist isokinetic exercise according to three conditions. As a result, wearing clothes with pressure effect and heat effect can show high efficiency in high muscle strength development and fast contraction activity during low speed exercise, and it is thought that it can show improvement of exercise ability through efficient recruitment of motor unit. However, the results of previous studies are still ambiguous about the effect of functional clothing on exercise ability and performance improvement, and the opinions of researchers are somewhat mixed, so it is necessary to verify the exact mechanism and verify the various angles according to the research method. Therefore, in this study, it is recommended to use compression heating sleeves to improve exercise performance during strength training.

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