

Effect of Functional Pressure Garments on EMG Response of the Agonist during the Resistance Exercise of the Wrist and Elbow Joint

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Abstract

The purpose of this study is to investigate the effects of functional compression clothing on muscle function by comparing the iEMG response of muscle during exercise according to the wearing of taping applied functional clothing. Six men in their twenties in Chungcheongnam-do were selected for the study. Resistance exercise was performed by cross-distributing the conditions of wearing and not wearing functional clothing. Resistance exercises for iEMG measurements are biceps curl, wrist curl, reverse wrist curl, kickback and push-up. iEMG measurement muscles were the biceps brachii, triceps brachii, extensor carpi ulnaris, flexor carpi radialis. During biceps curl exercise, the iEMG of triceps brachii, biceps brachii wearing condition was lower than the non-wearing condition. During kickback exercise, the iEMG of triceps brachii, extensor carpi ulnaris wearing condition was lower than the non-wearing condition. During reverse wrist curl exercise, the iEMG of extensor carpi ulnaris wearing condition was lower than the non-wearing condition. During wrist curl exercise, the iEMG of flexor biceps brachii, carpi radialis wearing condition was lower than the non-wearing condition. During push-up exercise, the iEMG of triceps flexor biceps brachii, carpi radialis, brachii, biceps brachii non-wearing condition was lower than the wearing condition.

Keywords: *Fucntional Pressure Garment, EMG, Resistance exercise, Wrist joint, Elbow joint*

1. Introduction

As the lifestyle that prioritizes the quality of life is pursued today, interest in sports apparel is increasing as a means to improve the ability to perform sports as the leisure culture spreads[1]. Among them, functional pressure garments, which is most popular, can prevent injury by providing joint stability[2], delays muscle fatigue during exercise due to reduced edema[3], and increases recovery speed after exercise[4]. Functional compression clothing can prevent blood flow from stagnation on the end of the body by intentionally pressing the muscles, and can increase venous blood regression, thereby effectively removing fatigue substances and metabolic products caused by muscle activity [5]. And improving blood circulation, it can help to recover fatigue by improving oxygen transportation ability[6]. The creatine kinase(CK), which is the damage factor of

muscle, can be effectively reduced. [7] reported that the group wearing functional pressure clothing showed less muscle damage than the group not wearing it when performing exercise load test, and [8] said that edema, pain and fatigue significantly decreased when wearing functional pressure clothing for 3 months.

The wearing of functional pressure clothing during exercise is effective in preventing damage by reducing vibration of muscles due to high elasticity and catching the surroundings of active muscles and joints[9], especially the excellent elastic recovery of functional clothing reduces elongation contraction in the muscle SSC mechanism and helps shortening contraction, thereby contributing to improvement of exercise ability[10].

As mentioned above, functional pressure clothing has been proven to help not only recover but also improve motor function. However, in order to increase its effect, research on functional pressure clothing using kinesio taping has been conducted recently[3]. Kinesio taping can be directly attached to the skin when there is injury or pain in the muscular and skeletal system, and it can expect the effect of pain management and injury prevention[11]. [12] said that taping treatment reduced muscle balance and muscle pain by improving circulation of blood, tissue fluid and lymphatic fluid. Especially during the game or training, taping is used as a means to manage damage and pain in the muscle and skeleton of the participants, and proper taping application according to the direction of movement of muscles and joints contributes to smooth contraction and relaxation of muscles[13]. Also, athletes in the sports field showed the effect of improving the performance through taping. [14] said that the number of repetition increased by about 25% when performing bench press after applying Kinesio taping and this is similar to the increase of about 10% muscle strength.

Thus, Kinesio taping can be easily applied to anyone and has no side effects, so it is widely used in general people, athletes, and skeletal patients. However, since taping can be used only as a one-time treatment, it requires manpower to tap each time, and because of the disadvantage that the adhesion becomes weak depending on the state of sweat or skin[15], it is required to develop new functional clothing applying taping treatment to functional pressure clothing, and researches for effect verification are actively conducted[3, 16]. However, since most of the functional clothing used in the study was limited to the products applied to the lower limbs such as thighs and calves, it is necessary to investigate the products for application to upper limb segments. This study was conducted to observe the changes in muscle activity when wearing upper extremity functional pressure clothing applied with kinesio taping.

2. Experiment Materials and Methods

2.1 Subject

Table 1 shows the physical characteristics of the subjects. The subjects of this study were 10 adult males who had no health problems in conducting the tests conducted in this study at C City D University. Before the experiment, the significance and measurement items of this study were explained to the subjects, and only the participants who received voluntary consent were selected.

Table 1. Physical characteristics of the subjects

	Age(yr)	Weight(kg)	Height(cm)
N=10	28.33±3.08	81.67±9.77	176.17±3.76

2.2 Study design

The purpose of this study is to investigate the effects of functional pressure clothing on muscle function.

Each subject was randomly assigned garment to measure EMG responses in wrist curl, reverse wrist curl, biceps curl, kick back, and push-up exercise under functional pressure garment application and unapplied conditions.

2.3 Functional compression garment

The functional stockings used in this study were BODINSAFE Co.(Korea). The functional pressure garment used in this study is composed of double structure of outer fabric and Lining. The Lining has elasticity similar to human muscle contraction and is designed to be cut and sewn in accordance with the contraction and relaxation direction of the muscles around the elbow joint. In 22.1N, the coefficient of extension(%) is vertical 96,7% and width 83.8% by Lining, vertical 96,8% and width 86.1% by outer fabric. Before the experiment, the subjects were measured the length from wrist to the center of humerus, the circumference of center of wrist and humerus, the circumference of wrist and made functional clothes suitable for each subject and wore them. The functional pressure garment design is shown in Figure 1. And Wearing appearance is shown in Figure 2.

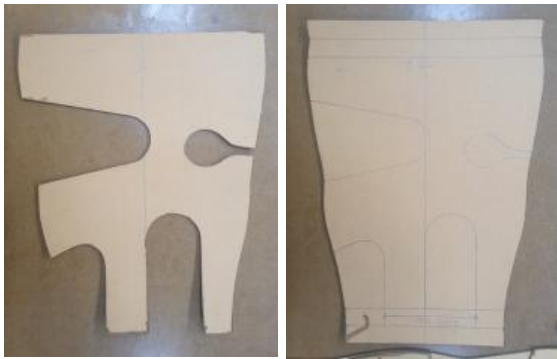


Figure 1. Functional pressure garment design



Figure 2. Wearing appearance

2.4 EMG measurement

The electrode was attached to flexor carpi ulnaris, extensor carpi radialis, biceps brachii, triceps brachii by referring to the data of [17]. Electrode of Flexor carpi ulnaris is located at the point of two fingers in distal direction from the medial epicondyle of humerus, and electrode of extensor carpi radialis is located at the point of two fingers in distal direction from the lateral epicondyle of humerus. electrode of biceps brachii is located at muscle bundle of humerus. and electrode of triceps brachii is located at the point of four fingers in distal direction from the posterior axillary fold. The surface electrode attachment is shown in figure 3.



Figure 3. Surface electrode attachment

2.5 Exercise method

This study consists of two kinds of wrist joint exercise, two kinds of elbow joint exercise, and one whole upper limb exercise. The method of exercise is as follows.

2.5.1 Dumbbell wrist curl

1. Subject is sitting on his knees in front of the flat bench.
2. Pronation the lower arm and place the wrist at the end of the flat bench with the wrist extended.
3. Hold the dumbbell and repeat the Flexion and Extension 10 times once every 2 seconds.

2.5.2 Dumbbell reverse wrist curl

1. Subject is sitting on his knees in front of the flat bench.
2. Supination the lower arm and place the wrist at the end of the flat bench with the wrist flexed.
3. Hold the dumbbell and repeat the Extension and Flexion 10 times once every 2 seconds.

2.5.3 Dumbbell biceps curl

1. The subject stands in anatomical position.
2. Hold the dumbbell and repeat the Extension and Flexion 10 times once every 2 seconds the elbow joint.

2.5.4 Dumbbell kick back

1. Subjects bend their trunk to support arms and knees in a non movement direction with the flat bench.
2. Attach the upper arm in the direction of movement to the trunk and flexion the elbow joint 90 °.
3. Hold the dumbbell with a neutral grip and fix the upper arm and repeat the elbow joint extension and flexion 10 times once every 2 seconds.

2.5.5 Isometric push up

1. The subject spreads his arms on the ground and lay his hands on the ground with his shoulders wide.
2. Down to the point where your elbow is flexion at 90 ° and stop for 10 seconds.

2.6 Statistical analysis

The variables measured in this study were SPSS software(ver 22.0) and the mean and standard deviation were calculated. The EMG response according to the application of functional pressure garment was analyzed by paired t-test. Statistical significance level was set at $\alpha=.05$.

3. Result

3.1 Difference of iEMG during Dumbbell wrist curl exercise

Table 2 shows the difference in iEMG during wrist curl exercise according to wearing functional clothing. When wearing functional clothing, iEMG tended to decrease in the biceps brachii and the flexor carpi radialis. And tended to increase in the triceps brachii and extensor carpi ulnaris.

Table 2. Difference of iEMG during Dumbbell wrist curl exercise(μV)

Muscle	Non-wearing	Wearing	t	p
Triceps brachii	10.19 \pm 4.65	14.00 \pm 7.96	-1.437	.210
Biceps brachii	32.95 \pm 15.33	30.36 \pm 15.18	.521	.624

Extensor carpi ulnaris	38.83±14.66	48.20±27.96	-.904	.407
Flexor carpi radialis	120.09±37.48	112.08±29.35	1.813	.129

3.2 Difference of iEMG during Dumbbell reverse wrist curl exercise

Table 3 shows the difference in iEMG during reverse wrist curl exercise according to wearing functional clothing. When wearing functional clothing, iEMG tended to decrease in the biceps brachii and the extensor carpi ulnaris, flexor carpi radialis. And tended to increase in the triceps brachii, biceps brachii.

Table 3. Difference of iEMG during Dumbbell reverse wrist curl exercise(μ V)

Muscle	Non-wearing	Wearing	t	p
Triceps brachii	13.89±6.38	17.70±9.34	-1.283	.256
Biceps brachii	12.27±5.88	14.19±4.00	-.651	.544
Extensor carpi ulnaris	179.05±40.13	166.27±54.11	.813	.453
Flexor carpi radialis	49.01±14.16	53.95±30.86	-.527	.621

3.3 Difference of iEMG during Dumbbell biceps curl exercise

Table 4 shows the difference in iEMG during bicepse curl exercise according to wearing functional clothing. When wearing functional clothing, iEMG tended to increase in the biceps brachii and the triceps brachii.

Table 4. Difference of iEMG during Dumbbell biceps curl exercise(μ V)

Muscle	Non-wearing	Wearing	t	p
Triceps brachii	38.15±11.48	36.15±16.20	.381	.719
Biceps brachii	207.90±63.10	202.39±65.41	.867	.426
Extensor carpi ulnaris	92.14±61.88	162.18±119.77	-1.843	.125
Flexor carpi radialis	96.51±43.73	96.73±38.60	-.046	.965

3.4 Difference of iEMG during Dumbbell kick back exercise

Table 5 shows the difference in iEMG during dumbbell kick back exercise according to wearing functional clothing. When wearing functional clothing, iEMG tended to decrease in the triceps brachii, extensor carpi ulnaris. And tended to increase in the biceps brachii, flexor carpi radialis.

Table 5. Difference of iEMG during Dumbbell kick back exercise(μ V)

Muscle	Non-wearing	Wearing	t	p
Triceps brachii	128.10±44.25	115.35±47.73	.840	.439
Biceps brachii	20.40±5.86	28.96±7.19	-2.758	.040
Extensor carpi ulnaris	61.90±22.26	51.45±18.63	.821	.449
Flexor carpi radialis	51.20±15.72	61.85±29.64	-.995	.365

3.5 Difference of iEMG during isometric push up exercise

The difference of iEMG during push-up exercise according to wearing functional clothing is the same as

Table 6. When wearing functional clothing, iEMG tended to increase in the upper limbs, upper limbs, and right limbs and the right wrist flexor.

Table 6. Difference of iEMG during isometric push up exercise(μV)				
Muscle	Non-wearing	Wearing	t	p
Triceps brachii	252.34 \pm 89.47	253.03 \pm 144.53	-.023	.982
Biceps brachii	26.37 \pm 14.34	29.26 \pm 10.15	-.658	.540
Extensor carpi ulnaris	25.57 \pm 9.21	35.60 \pm 25.93	-1.305	.249
Flexor carpi radialis	46.18 \pm 13.75	49.48 \pm 20.06	-.342	.746

4. Discussion

Functional clothing has better fixation than taping[15], and it has a positive effect on blood flow improvement because it presses muscles and joints, and it is known to be effective in recovery after exercise [10]. Functional clothing can prevent muscle damage due to exercise because of suppressing vibration of muscle and good joint fixing force[2]. It has the advantage that it repetitively can use without the treatment person[18]. Also, taping applied to functional clothing is used as a means to manage damage and pain in the muscle and skeleton of exercise participants during a game or training to perform dynamic movement. The effect of gamma-reflex due to physical stimulation such as contact feeling and pressure feeling of the part in contact with the skin is improved by extending the intramuscular fiber in the muscle fiber[20]. It can contribute to smooth contraction and relaxation[13].

In this study, iEMG tended to decrease in biceps brachii and flexor carpi ulnaris during Wrist curl exercise. The Wrist curl exercise is used as an agonist for flexor carpi ulnaris[20], and the biceps brachii plays a role in stabilizing the elbow joint. Conversely, extensor carpi radialis and triceps brachii act as antagonists. The inability of iEMG to increase in the submaximal muscle activity indicates that the exercise unit is less desired, that is, the muscular strength efficiency of muscle fiber is high[21]. When wearing functional clothing, the Wrist curl exercise seems to have mobilized relatively less muscle fiber than the non-wearing condition, which is considered to be able to lift weight with less force due to the strength efficiency due to the support of shortening shrinkage due to the elasticity of functional clothing and the SSC mechanism[14].

In addition, the stimulation of the area in contact with functional clothing may have contributed to the improvement of muscle strength by the extension of my internal muscle fibers due to gamma motion reflection[12]. On the other hand, iEMG tended to increase in the triceps brachii and the extensor carpi radialis which antagonize in wrist curl exercise, which is considered to increase the activity of the antagonist to stabilize the joint compared to the increased muscle strength of the main muscle because the structure of functional elastic stockings restricts the contraction direction of the muscle and provides stability to the muscles and joints[13].

In reverse wrist curl exercise, iEMG tended to decrease only in the extensor carpi radialis. In wrist extensor movement, the extensor carpi radialis acted as the main muscle and the flexor carpi ulnaris acted as the antagonist[20]. In order to extension the wrist by resisting the load while the wrist is flexion, the elasticity of functional clothing supports the muscular strength expression, so the exercise unit is thought to be mobilized less[14]. The increased iEMG of flexor carpi ulnaris, biceps brachii and triceps brachii may be due to the maintenance of the elbow joint at 120°, and biceps brachii and triceps brachii may have acted as stabilizer. Also, because the wrist was pronated and exercised, the tension of the biceps brachii increased and the muscle

activity increased.

The iEMG tended to decrease in triceps brachii and biceps brachii during the biceps curl exercise, and the tendency to increase in extensor carpi radialis and flexor carpi ulnaris. In the biceps curl exercise, biceps brachii acts as agonist, triceps brachii acts as antagonist, and extensor carpi radialis and flexor carpi ulnaris stabilize the wrist joint[20]. The biceps brachii, was considered to have been able to perform exercise while mobilizing less motor units thanks to the elastic force of functional clothing[14].

In the kick back exercise, iEMG decreased in triceps brachii and extensor carpi radialis, and it tended to increase in biceps brachii and flexor carpi ulnaris. The triceps brachii is thought to be affected by the elasticity of functional clothing because triceps brachii acts as agonist and biceps brachii act as antagonist[20], and the contraction of triceps brachii is thought to be affected by the elasticity of functional clothing[14]. iEMG increased in biceps brachii is considered that it appeared in preparation for the effect of increasing power[15].

iEMG tended to increase in all muscle during isometric push up exercise. This seems to be the highest ability of push-up exercise with functional pressure clothing than non-wearing push-up exercise. This result is consistent with the previous studies that showed a linear relationship between iEMG and isometric contraction of the gastrocnemius and the soleus[22]. In addition, [23] reported that the iEMG increased over time due to the occurrence of activity potential when the maximum veterinary isometric contraction was performed.

5. Conclusion

In conclusion, when wearing functional clothing with taping effect, flexor carpi ulnaris and biceps brachii were decreased during dumbbell wrist curl exercise, and muscle activity of extensor carpi radialis was decreased during reverse wrist curl exercise. In the biceps curl exercise, the activity of biceps brachii and triceps brachii decreased, and the activity of triceps brachii and extensor carpi radialis decreased during the kick back exercise. In isometric push-up exercise, muscle activity of all muscles tended to increase. In summary, it is considered that wearing functional clothes with taping effect during exercise can provide stability to active muscles and joints, improve muscular strength efficiency of agonists due to elastic recovery which is the effect of taping, delay the occurrence of muscle fatigue, and increase muscle contraction so that it can exert greater power in activities requiring maximum muscle strength. It is necessary to conduct follow-up studies on other musculoskeletal disorders or on application of different body segment in the future.

Acknowledgment

This paper was selected as an excellent paper at the 7th IIBC 2019 General Conference.

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