대한물리치료과학회지
Journal of Korean Physical Therapy Science 2017; 24(3): 39-47
ISSN 1226－3672, http://dx.doi.org/10.26862/jkpts.2017.12.24.3.38

The Effects of Mental Practice about Leg Exercise Muscle Activities of the Rectus Femoris

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Abstract

Purpose: This study aimed to investigate the effects of mental practice about leg exercise muscle activities of the rectus femoris. **Method:** 20 subjects were participated in this study. The values before the experiment were measured and those after the mental performance from the first experiment to the fifth experiment were measured. Electromyography (EMG) was used to measure the muscle activity of rectus femoris. **Result:** The muscle activity of the both rectus femoris after mental practice increased steadily and showed significant differences. **Conclusion:** In the present study, it was found that the muscle activity of both legs was increased during the mental practice. It can be seen that there was a difference before and after mental practice, and muscle activity of rectus femoris was increased.

Key words : Mental Practice, Leg Exercise, Muscle Activities

Ⅰ. Introduction

Mental practice is a method of motor learning that acquires/ promotes motor skills by thinking that you are performing the target movement in your mind without using body movements and imagining the scene of performing the task through it (Richardson, 1967). Mental practice is also known to be a useful way to stimulate brain activation and to promote real practice (S. Ionta, A. Ferretti, A. Merla, A. et al. 2009). Richardson defined mental practice as 'Imagining the symbols of physical activity without any great muscle movements'.

It was reported that the regions of the brain activated in the pre-motor area, parietal lobe, basal ganglia, and cerebellum coincide between the mental practice and the actual movement, and the patterns between the two stimuli are also very similar in EEG results (A. J. Bulter and S. J. Page 2006). In fact, mental practice was used for free throws of basketball and dart throws and it was reported that similar performance was improved when compared to the group that physically practiced this skill. Vandell et al (1943) and Suin (1980) asked a skier to

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imagine sliding down a hill and observed the electrical activity of the leg muscles, and reported that the muscles used for actual skiing were activated. Harris and Robinson (1986) reported that a student who is good at Karate (martial arts in Japan) showed higher activation of the shoulder deltoid on the EMG when performing mental practice. And Shaw (1940)'s study also reported that when weight lifters imagine they lift a heavy one, the more clear the imagination is, the greater the imagination that lifts the heavier one, the greater the degree of tension in the muscle. As shown above, the mental practice is widely used in various fields such as sports field, education field, and healthcare field including rehabilitation treatment. In the field of sports, mental training is used to increase expectations for motivation, relaxation, and achievement of goals, and is actually contributing to maximizing exercise performance (Garfield and Bennett, 1984). Although mental practice has been studied extensively in sports as a means of performance optimization for the elite athlete, the domain that we are interested in is skills acquisition for the novice (Cocks et al, 2014). Over the past decade, general surgeons and gynecologists have developed a small body of literature highlighting the potential role of MP in resident surgical education (Arora et al, 2011;Geoffrion et al, 2012).

As shown above, the application of mental practice in sports is more effective in archery, golf, basketball, etc. with accurate possible goals. In addition, it is also used to acquire and maintain new exercise skills for healthy people and the elderly (Linden et al, 1989).

The advantage of the mental practice is that it can be effectively used to improve and maintain motor skills in various fields. In addition, there is no need for expensive treatment equipment, and once you learn the mental practice course, you can practice it anywhere and at any time (Van Leeuwen and Inglis, 1998). Mental training has the advantage of making training everyday life because once the training is done, the patient can practice it on his/he own (Appel, 1992). The mental practice is useful for teaching a variety of motor skills and performances to patients with high fatigue because it consumes less energy than actually performing the exercise repeatedly (Maring, 1990). Motor imagery can be an alternative to improving motor skills in situations where physical training can not be done normally. For example, one can practice through imagery in situations where he/she is not able to participate in physical training normally for a variety of reasons, such as bad weather, injury, differences in equipment and skill levels (Choi DJ, Choi So, Kim DH, 2010). However, the disadvantage of mental practice is that it is difficult to apply to subjects who have limited imagination or have no confidence in this method. In addition, it is difficult to correct the subject's mistake in the mental practice because the therapist can not observe if the subject is doing mental practice correctly.

Of studies on mental practice, there are not many cases where it is applied to healthy persons whose goal or task is unclear. Most studies on mental practice have focused on aspects of neural rehabilitation training and on improvement of athletic performance of athletes, and there have been few EMG studies on mental practice. Based on this point, this study was to find out the effect of mental practice on healthy persons by performing electromyography on the mental practice without stopping in patients. In order to increase expectations for motivation, relaxation, and achievement of goals when a healthy person acquires new movements, difficult exercises and maximize actual exercise performance in situations where he/she is not able to participate in physical training normally for a variety of reasons, such as weather problems or injuries, or differences in equipment and skill levels, this study examined the changes in muscle activity of rectus femoris of both sides when the mental practice was performed for leg extension exercise and squatting exercise.

Ⅱ. Method

1. Subjects

This study was conducted for 20 healthy male students with no disease from Department of Physical Therapy, G University from 20 May 2013 to May 24, 2013.

1) General characteristics of subjects

General characteristics of subjects are shown in Table 1.

Table 1. General characteristics (n=20)

	AVR±SD
Age (year)	24.15 ± 0.55
Height (cm)	174.90 ± 7.70
Weight (kg)	70.00 ± 9.09

2) Experimental method

The experiment was performed by applying an instructional method with a mental practice method. Leg extension exercise and squatting exercise in which rectus femoris acts as an agonistic muscle were made as a video and a recording file and used in the mental practice method. The subject sits in a chair, watches the edited video of three minutes, and listens to the recorded file of about six minutes with his/her body relaxed. In order to increase the concentration, the subject was engaged in the experiment by plugging in earphones in a quiet room without noise where he/she could hear the video and recorded file (Figure 2).

3) Experimental measurement method

The values before the experiment were measured and those after the mental performance from the first experiment to the fifth experiment were measured. EMG was used to measure the muscle activity of rectus femoris. The active electrode of the EMG was attached to the center of the rectus femoris to detect EMG signals generated during muscle contraction and the reference electrodes were attached to the part close to the knee bone of muscle quadratus femoris tendon. In order to reduce the error between the electrode and skin, hair was removed with a razor at the measurement site, the skin was cleaned with a medical alcohol or a water towel, and then the electrode was attached. For measurement, leg extension exercise was performed in NK-table (figure 1) and each weighed 10kg and the muscle activity of rectus femoris during 90° knee extension exercise with both knees bent by 90° was measured.

2. Analysis method

This study used PASW statistics 18.0 statistical package for data analysis. This study performed a total of 6 measurements for 3 days and used the descriptive statistics to find out changes in muscle activity at each measurement. The repeated measurement variance analysis was performed to analyze the changes of the left and right rectus femoris over time. When the significance was shown according to the period, a contrast test was performed to check a significant period of time between each measurement. A statistical significance level a was set to 0.05 for the test.

Ⅲ. Results

All the experiments were performed 6 times at intervals of 3 days for 2 weeks, and values before and after the experiment were measured in left and right, respectively.

1. Right rectus femoris

Table 2 shows the effect of the mental practice on the muscle activity of the right rectus femoris. The muscle activity was continuously increasing: 45.20 ± 20.77 before the experiment, 50.40 ± 23.16 after the 1st experiment, 73.82 ± 36.13 after the 2nd experiment, 78.63 ± 40.64 after the 3rd experiment, 76.77 ± 38.20 after the 4th experiment, and 87.42 ± 38.10 after the 5th experiment. As a result, there were significant differences according to the period, and the result of the contrast test showed that there were significant differences in all of the 2nd, 3rd, 4th, and 5th except for the 1st compared with before the experiment (Table 3).

2. Left rectus femoris

Table 4 shows the effect of the mental practice on the muscle activity of the left rectus femoris. The muscle activity was continuously increasing: 42.33 ± 18.44 before the experiment, 53.23 ± 2.87 after the 1st experiment, 68.17 ± 26.69 after the 2nd experiment, 67.17 ± 28.56 after the 3rd experiment, 72.64 ± 35.84 after the 4th experiment, and 76.79 ± 28.16 after the 5th experiment. The results of the statistical analysis are shown in (Table 5). As a result, there were significant differences according to the period, and the result of the contrast test showed that there were significant differences in all of the 1st, 2nd, 3rd, 4th, and 5th compared with before the experiment (Table 6).

Ⅳ. Discussion

Recently, the mental practice has been widely used for the rehabilitation of patients with motor disorder such as stroke and for the reasons such as the movement of athletes, the promotion of motor learning, and the improvement of exercise performance. In the mental practice, stroke patients are given appropriate tasks such as weight support activities, mobility training, gait function, and daily life motions, and goals are given in sports such as archery, skiing, golf and basketball, while there are not many cases where it is applied to a healthy person whose goal or task is unclear. In addition, as the level of people's living improves and the industrial society develops, various adult diseases are emerging as serious social problems due to increased leisure time caused by growth and automation of the industry, lack of physical activity that hinders the health of modern people, illness due to irregular life and various stresses, westernization and aging, so muscle strength and leisure physical activity have increased as interest in health grows but there are many people who can not exercise because of lack of time or inappropriate circumstances. For this reason, this study was to find out the changes in muscle activity of rectus femoris when the mental practice was applied to healthy people.

The muscle activity measured by electromyography can be used as objective data to estimate muscle strength and performance (Gentili et al, 2006). In other words, increased muscle activity during a certain movement can be perceived as an increase in movement units participating in muscle contraction, which means that muscle strength and performance capability have been improved (Basmajian et al, 1985). The method of mental practice is effective when combining visual imagination and concrete action imagery (Hall et al, 1992). It is recommended that the mental practice time is within 10 minutes (Dunsky et al, 2006). Based on the results of these previous studies, the mental practice program in this study was configured to run for 10 minutes and included concrete imagination of visual imagination and movement.

The reason for choosing squatting and knee extension exercise in this study is because they are typical exercises that develop lower body strength and develop muscle quadratus femoris, a typical muscle around the knee joint. Seeing that when weight lifters imagine lifting a heavy one, the more clearly they imagine it, the more they imagine lifting a heavier one, the greater the strain on the muscles in the Shaw (1940)'s study, we gradually increased the weight in the mental practice of this study. The research of Jin-Seop Kim et al and Sun-Yeop Kim, Deok-Won Oh (2008) explains that the possibility of improving muscular strength and muscle activity through mental practice for hemiplegic patients. The above study examined whether the mental practice can change the muscle activity of muscle quadratus femoris in one patient with hemiplegia. In this study, the muscle activity of the affected muscle quadratus femoris in patients with hemiplegia was found to have increased. This study targeted healthy people, not hemiplegic patients. As a result, the muscle activity of muscle quadratus femoris increased when mental practice was applied to healthy people. Additionally, during the coding process, we did note multiple overlapping cues, even among this small sample of interviews. Of note, most of our participants were female, limiting the generalizability of our findings (Sevdalis et al, 2013).

Considering the problem of the accuracy of the mental practice applied in the experiment of this study, it was assumed that there may have been a difference in the efficiency of accepting mental practice stimulation according to the human body rhythm because the time of mental practice for the subjects was not exactly the same every day. In addition, since the strengths and durations of the mental practice are not defined clearly in the existing literature, it is unclear whether the mental practice applied in this study was appropriate in terms of strength or duration. The limitation of mental practice was that it is difficult to apply to subjects who have limited imagination or have no confidence in this method. In addition, it is difficult to correct the subject's mistake in the mental practice because it cannot be observed if the subject is doing mental practice correctly. These limitations need to be supplemented and a check method for correct imagination training of the subject is needed (Waner and McNeil, 1988). In addition, there was a difficulty in selecting the experiment task because this study was to find out the muscle activity through the mental practice for general healthy people who have no special purpose or task such as stroke patients or athletes. The focus is only on changes in the muscle activity of muscular rectus femoris only by watching and listening rather than mixing and using various muscles such as walking or balancing of stroke patients.

Since this study is more limited and localized than other previous studies, the results of this study alone are not sufficient to show that the mental practice increases the muscle activity for all muscles of healthy people. For this reason, there are many limitations in generalizing the results of this study. Therefore, studies involving more subjects and applying mental practices for a longer period of time should be continued. In addition, studies should be carried out to evaluate the effects of mental practice for various tasks and include many muscles that meet the task characteristics in evaluating the effects.

Ⅴ. Conclusions

This study conducted the experiment for 20 healthy male students to find out the effect of mental practice on the muscle activity of bilateral rectus femoris. The results are as follows:

1. The muscle activity of the right rectus femoris after mental practice increased steadily and showed significant differences as follows: 45.20 ± 20.77 before the experiment, 50.40 ± 23.16 after the 1st experiment, 73.82 ± 36.13 after the 2nd experiment, 78.63 ± 40.64 after the 3rd experiment, 76.77 ± 38.20 after the 4th experiment and 87.42 ± 38.10 after the 5th experiment.

2. The muscle activity of the left rectus femoris after mental practice increased steadily and showed sig-

nificant differences as follows: 42.33 ± 18.44 before the experiment, 52.23 ± 2.87 after the 1st experiment, 68.17 ± 26.69 after the 2nd experiment, 67.17 ± 28.56 after the 3rd experiment, 72.64 ± 35.84 after the 4th experiment and 76.79 ± 28.16 after the 5th experiment.

In conclusion, it was found that the muscle activity of both legs was increased during the mental practice. It can be seen that there was a difference before and after mental practice, and muscle activity of rectus femoris was increased. Thus, it was found that mental practice is also effective when applied to general healthy people, not stroke hemiplegic patients or sports players. It can be interpreted to be a positive way to increase the efficiency of patient treatment or increase the muscular strength of healthy people.

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This study was received Nov. 2, 2017, was reviewed Nov. 23, 2017, and was accepted Dec. 6, 2017.

Appendix 1. Table

Table 2. The Effect of the Mental Practice on the Muscle Activity of the Right Rectus Femoris (n=20)

	M±SD
Before experiment	45.20 ± 20.77
1st experiment	50.40 ± 23,16
2nd experiment	73.82 ± 36.13
3rd experiment	78.63 ± 40.64
4th experiment	76.77 ± 38.20
5th experiment	87.42 ± 38.10

Table 3. Muscle Activation of the Right Rectus Femoris by the Period

	SS	df	MS	F	p
pre−experiment 1st	540.800	1	540.800	1.470	0.240
pre−experiment 2nd	16376.364	1	16376.364	19.613	0.000*
pre−experiment 3rd	22357.984	1	22357.984	24.054	0.000*
pre−experiment 4th	19926.984	1	19926.984	15.837	0.001*
pre−experiment 5th	35642.124	1	35642.124	27.296	0.000*

*p<0.05

Table 4. The Effect of the Mental Practice on the Muscle Activity of the Left Rectus Femoris (n=20)

	M±SD
Before experiment	42.33 ± 18.44
1st experiment	53.23 ± 22.87
2nd experiment	68.17 ± 26.69
3rd experiment	67.17 ± 28.56
4th experiment	72.64 ± 35.84
5th experiment	76.79 ± 28.16

Table 5 . The Results of the Statistical Analysis of Left Rectus Femoris

	SS	df	MS	F	P
left rectus femoris	16980.153	5	3396.031	8.215	0.000*

* $p<0.05$

Table 6. Muscle Activation of the Left Rectus Femoris by the Period

	SS	df	MS	F	P
pre−experiment 1st	2374.020	1	2374.020	5,308	0.032
pre−experiment 2nd	13348.944	1	13348.944	17.804	0.000*
pre−experiment 3rd	12345.480	1	12345.480	37.564	0.000*
pre−experiment 4th	18367.860	1	18367.860	25.610	0.000*
pre−experiment 5th	23749.832	1	23749.832	36.707	0.000*

* $p<0.05$