Electromyographic Activity of the Gluteus Maximus on the Weight-Bearing Side During Lateral and Frontal Wall Press Exercises

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Abstract

Background: The lateral wall press (WP) exercise is one of the weight-bearing exercises used in gluteal muscle strengthening programs. However, little is known about the muscle activity level of the gluteus maximus (Gmax) on the weight-bearing side during the lateral WP exercise. The primary actions of the Gmax are hip extension and hip external rotation. In addition, the superior area of the Gmax also functions as a hip abductor. We hypothesized that not only lateral but also frontal WP exercise might be suitable for Gmax strengthening.

Objectives: The purpose of this study was to quantify electromyographic (EMG) activity of Gmax in weight-bearing side during lateral and frontal WP exercise.

Patients and Methods: Twelve healthy women (university students) participated in this study. The surface EMG was used to quantify the activity of the Gmax on the weight-bearing side during lateral and frontal WP exercises. The exercises were done with opposite leg. A paired t-test was used to examine the significance of differences in the Gmax activity between the lateral and frontal WP exercises.

Results: The means ± standard deviations of the averaged EMG during the lateral and frontal WP exercises were 40.1 ± 19.1, and 23.7 ± 11.3 µV, respectively. Those of the percent maximal voluntary contraction during the lateral and frontal WP exercises were 51.4 ± 29.7, and 31.3 ± 20.5, respectively. Gmax activity during the lateral WP exercise was significantly higher than that during the frontal WP exercise.

Conclusions: The results of this study indicate that the lateral WP exercise is more suitable than the frontal WP exercise for strengthening the Gmax on the weight-bearing side.

Keywords: Weight Bearing Strengthening Program, Electromyography, Hip, Muscles

1. Background

Patellofemoral pain syndrome (PFPS) is one of the most common disorders affecting the lower extremities. It frequently occurs among the physically active population, with a higher incidence in women (1). The most common reason for PFPS is overuse (1). It is theorized that impaired gluteal muscle function may result in increased hip joint adduction and internal rotation movement during activities such as running, squatting, and descending stairs (2). This excessive hip motion is proposed to increase the lateral patellofemoral joint stress associated with PFPS development (2). Supporting this theory, gluteal muscle strengthening programs have been associated with a positive clinical outcome in individuals with PEPF (3-8).

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rotation, and extension exercises (14-21). A systematic review demonstrated that EMG activity for Gmed ranged from 12 to 103% MVC and Gmax ranged from 4 to 113% MVC during hip abduction and hip external rotation exercises (21). EMG activity can be affected by changes in body position and complexity of the exercise (14-21). These studies provide an indication for the amount of muscle activity generated by basic strengthening and rehabilitation exercises, which may assist practitioners in making decisions for Gmed and Gmax strengthening and injury rehabilitation programs. When strengthening a weaker muscle, practitioners may wish to prescribe a gradual and progressive exercise program to ensure the targeted area is developed. This may be of importance if individuals implement a compensatory movement pattern when faced with weakness or dysfunction (21).

Lateral wall press (WP) exercise is one of the weight-bearing exercises of the gluteal muscle strengthening programs (Figure 1) (3). This exercise requires the hip on the weight-bearing side to maintain relative hip abduction despite the creation of an abduction torque by the opposite knee pushing laterally against the wall (14). O'Sullivan et al. (14) demonstrated that the lateral WP exercise is an effective isometric strengthening exercise for Gmed using EMG. However, little is known about the activity level of Gmax on the weight-bearing side during the lateral WP exercise. The primary actions of the Gmax muscle are hip extension and hip external rotation (17), and the superior area of the Gmax also functions as a hip abductor (22). We considered that the frontal WP exercise could require the hip on the weight-bearing side to maintain a relative hip extension despite the creation of a flexion torque by the right knee pushing forward against the wall (Figure 2). We hypothesized that not only lateral but also frontal WP exercise might induce high EMG activity in the Gmax.

2. Objectives

The purpose of this study was to quantify the EMG activity of the Gmax on the weight-bearing side during lateral and frontal WP exercises.

3. Patients and Methods

3.1. Participants

Twelve healthy women (university students) participated in this study. Their age, height, and weight (Mean ± SD) were 20.3 ± 0.5 years-old, 158.1 ± 3.6 cm, and 51.5 ± 4.3 kg, respectively. All participants were right-handed. None of them had a history of limb surgery or neuromuscular disorders. The study was explained to the subjects, whose verbal consent was obtained prior to their participation.

3.2. Procedure

The surface EMG was conducted using the MQ8 system (Kissei Comtec, Japan). Skin preparation of the electrode sites involved cleansing with alcohol. Disposable silver/sil-
G-Power software (Franz Faul, Universitat Kiel, Germany) was also used to calculate the post-hoc effect size and actual power of the sample.

4. Results

The Mean ± SD of the averaged EMG during the lateral and frontal WP exercises were 40.1 ± 19.1, and 23.7 ± 11.3 µV, respectively. The averaged EMG of the Gmax during the lateral WP exercise was significantly higher than that during the frontal WP exercise (P = 0.001, 95% confidence interval = 8.1-24.8, effect size = 1.25, power = 0.98).

The percent MVC of the Gmax for each of three attempts during the lateral and frontal WP exercises was showed in Figure 3. The Mean ± SD of the percent MVC of the Gmax during the lateral and frontal WP exercises were 51.4 ± 29.7, and 31.3 ± 20.5, respectively. The percent MVC of the Gmax during the lateral WP exercise was significantly higher than that during the frontal WP exercise (P = 0.001, 95% confidence interval = 10.5-29.7, effect size = 1.33, power = 0.99).

This requires the hip on the weight-bearing side to maintain a relative hip abduction despite the creation of an adduction torque by the opposite knee that is pushing laterally against the wall.

This requires the hip on the weight-bearing side to maintain a relative hip extension despite the creation of a flexion torque by the opposite knee that is pushing forward against the wall.

The Mean ± SD of the percent maximal voluntary isometric contraction (MVC) of the gluteus maximus for each of three attempts during the lateral and frontal wall press (WP) exercises.
5. Discussion

To the best of our knowledge, this study is the first to quantify the EMG activity of the Gmax on the weight-bearing side during lateral and frontal WP exercises. Our results show that lateral and frontal WP exercises induce “high” and “moderate” muscle activity of Gmax, respectively (13). The intensity of the Gmax activity during the lateral WP exercise may be suitable for providing strength (12). There are various Gmax strengthening exercises, and details of intensity of the Gmax activity during those exercises were reported in a systematic review (21). For example, the intensity of the Gmax activity during the lateral WP exercise was similar to that during the lateral step up (49.6% MVC) and transverse lunge (53.5% MVC), which are classified as Gmax high-activity exercises (21). By knowing the Percent MVC of the Gmax that occurs during various exercises, potential for strengthening of the Gmax can be inferred (15). Additionally, exercises may be rank ordered to appropriately challenge the Gmax during rehabilitation.

A study reported that the hip strength of abduction was lower compared to that of flexion (25). The difference in the Gmax activity between the lateral and frontal WP exercises might be related to not only the creation of an addiction or flexion torque of the hip on the weight-bearing side by pushing the opposite knee laterally or frontally against the wall, respectively, but also to the requirement of the hip external or internal rotation during the exercises. To maintain balance, a relative hip external rotation was required in the lateral WP exercise, whereas, a relative internal rotation was required in the frontal WP exercise. The primary actions of the Gmax are hip extension and hip internal rotation (17), and the superior area of the Gmax also functions as a hip abductor (22). In this study, activity in the superior area of the Gmax was detected using EMG. To maintain relative hip abduction and external rotation during the lateral WP exercise, a higher activity of Gmax might be elicited compared to that elicited during the frontal WP exercise. Our results indicate that the lateral WP exercise is more suitable for strengthening the Gmax on the weight-bearing side than is the frontal WP exercise.

We recognize several limitations of our study, including the use of healthy subjects and not recording the subjects’ hip joint movements during the exercises. Our participants were healthy, thereby limiting the generalization of our findings to individuals with reduced hip muscle performance. Additional research must be conducted in populations with PFPS to increase the clinical applicability of our findings. Before data collection, the subjects were trained to perform the lateral and frontal WP exercises by the same investigator. However, we did not record hip joint movements during the exercises. Thus, we cannot claim that the exercise position was uniform across the subjects. Further investigation is necessary to clarify the activity level of the Gmax during the lateral and frontal WP exercises in PFPS individuals. In conclusion, the subjects only performed the WP exercise in this study. Future studies should investigate exercises other than the WP exercise to examine Gmax activity and to generalize the findings.

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Footnote

Authors’ Contribution: Study concept and design: Hiroshi Ishida, Hikari Kinoshita, and Yuri Toyoura; acquisition of data: Hikari Kinoshita and Yuri Toyoura; analysis and interpretation of data: Hiroshi Ishida, Hikari Kinoshita, Yuri Toyoura, and Susumu Watanabe; drafting of the manuscript: Hiroshi Ishida; critical revision of the manuscript for important intellectual content: Hiroshi Ishida and Susumu Watanabe; statistical analysis: Hiroshi Ishida, Hikari Kinoshita, and Yuri Toyoura; administrative, technical, and material support: Hiroshi Ishida, Hikari Kinoshita, and Yuri Toyoura; study supervision: Susumu Watanabe.

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