



Original Article

Effect of abdominal drawing-in maneuver with prone hip extension on muscle activation of posterior oblique sling in normal adults

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Abstract. [Purpose] There have been many studies on ipsilateral erector spinae in regard of prone hip extension (PHE). However, mediating methods have been focusing on the reinforcement of gluteus. Hereupon, this study is intended to identify how an increase of abdominal drawing-in maneuver influences on posterior oblique sling (POS) and suggest a mediating method to effectively reinforce them. [Participants and Methods] This study has been conducted on normal male (10) and female (10), and participants were asked to prove PHE exercise and abdominal drawing-in maneuver prone hip extension exercise (ADIM PHE). Surface electromyography (EMG) was recorded from the contralateral latissimus dorsi, ipsilateral erector spinae, ipsilateral gluteus maximus, and ipsilateral biceps femoris. A paired t-test was used to compare muscle activity POS. [Results] EMG activity of the contralateral latissimus dorsi, ipsilateral gluteus maximus was significantly greater performed ADIM PHE than PHE. As for ipsilateral erector spinae muscle, ipsilateral biceps femoris activation was lower in ADIM PHE than PHE. [Conclusion] According to the results of this study, abdominal drawing-in maneuver seems to be an important factor that influences on muscular activation of POS.

Key words: Posterior oblique sling, Abdominal drawing-in maneuver, Prone hip extension

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INTRODUCTION

Muscular chains are the groups of muscles that affect the pattern in which the muscles work or exercise together. Muscle chains have the form of synergists, muscle slings and myofascial chains, each of which has an interdependent relationship with the joint or nerve tissue. Among them, when walking crosswise, the front and trunk stability of the body, and the back muscle slings that transfer force from the lower to the upper part of the body, are composed of the opposite side of the latissimus dorsi muscle, thoracolumbar fascia, ipsilateral erector, ipsilateral gluteus maximus, ipsilateral hamstring¹⁾. Because the latissimus dorsi muscle located on the opposite side of the gluteus maximus are functionally connected by the thoracolumbar fascia, the mechanism for conveying the force diagonally opposite legs from the arm is taken into account, and these models are an important driver for motor programs for back pain patients²⁾. When functional operation is performed, the weakening and reduced activity of the gluteus maximus may result in excessive activity of the hamstring and erector spinae muscles³⁾.

Muscular strength training of the gluteus maximus is an important exercise for patients with back pain and damage of lower extremities⁴⁾. If gluteus maximus are weakened, several studies have been conducted to implement the hardening movement in the most efficient and best way. There are exercises such as two-legged squats and one-legged squats, but

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these can be too much for patients with joint pain or lack of stability. So, the exercise that is used a lot for gluteus maximus' selective muscle strengthening exercise is commonly used the Prone hip extension (PHE) with the prone position⁵⁻⁷.

Oh et al.⁸) reported in PHE the abdominal drawing-in maneuver (ADIM) that using the pressure bio-feedback unit(PBFU) reduces the activity of erector spinae muscles and increases the activity of gluteus maximus. Therefore, it helps to strengthen gluteus maximus' selective muscle strength. In another study, PHE exercise without applying ADIM to female patients with chronic back pain with weakened significantly increases back muscle-sling activity⁹).

Simultaneous activity of the global muscles is the result of increasing the compression load on the lumbar spine segment, causing rotation to occur on the trunk, applying a compression load to the spine¹⁰). In patients with back pain is compared with normal people, the activity of the global muscles increases, and at the same time contractions are found, resulting in inappropriate trunk muscle control¹¹).

Through prior study, PHE has been proven to influence back muscle sling, ADIM increase the strength of gluteus maximus and reduces the activity of erector, biceps muscle. However, there is no study on back muscle slings through ADIM. Therefore, the purpose of this study is to check the change in activity of back muscle slings by applying ADIM among PHE, which are commonly used as muscle exercises in gluteus maximus.

PARTICIPANTS AND METHODS

Participants for this study are 20 normal persons who are in D College located at Dae-gu province, and the researcher classified the participants for study in random allocation method. Participants have general characteristics of average age of 24.03 ± 4.41 , average height of 168.64 ± 9.03 cm, and average weight of 63.74 ± 9.60 kg (Table 1).

Selection criteria include in the last 6 months, no abnormalities in the muscular system of the trunk and lower extremities, no congenital deformities or orthopedic diseases, no neurological damage, fully informed of the purpose and contents of this study and agreed to participate in the study in accordance with the ethical principles of the Helsinki Declaration.

Prior to the experiment, the participants were trained on the PHE method for about 30 minutes.⁸) The gluteus maximus in leg of the side which is usually used is said the east to set the direction of back muscle slings. Only those with dominant right leg participated in the experiment. During PHE when 10° position by measuring the activity of the hip joint (Fig. 1). ADIM PHE measured activity up to 10° hip joint using pressure bio-feedback units (Fig. 2).

The measurement tool used in this study used an 8-channel wireless electromyography WEMG-8 (LXM5308, Laxtha, Daejoen, Korea) to measure the activity of the back muscle sling. A goniometer (Prestige medial, Chicago, IL, USA) was used to measure the angle of the hip joint. Equipment stabilizer (Chattanooga, TN, USA) was used for ADIM.

The electrode pad used to measure muscle conduction was attached to the dominant side of the muscle. The latissimus dorsi muscle on the opposite side is attached 4 cm below the lower angle of the scapula and at the midpoint of the side edge of the spine and the scapula medial border. In the case of erector spinae muscles on the dominant side, the electrodes are attached to the muscle belly, which is 2 cm outward from 1st lumbar spine. The gluteus maximus of the dominant leg is attached to the muscle belly in the middle of the line connecting the greater trochanter from the lower inferior lateral angle of the sacrum¹²). The cables connecting the muscle conduction equipment and the electrode pad are well organized to minimize noise on movement. The signal was observed by designating a channel corresponding to the muscles connected to each cable in the laptop connected to the muscle conduction equipment, and the sampling rate of the collected signal was 1,024 Hz.

Table 1. General characteristics of the participants

	Age (years)	Height (cm)	Weight (kg)
participants (n=20)	24.0 ± 4.4	168.6 ± 9.0	63.7 ± 9.6

All values are mean \pm standard deviation (SD).



Fig. 1. Prone hip extension.



Fig. 2. Abdominal drawing-in maneuver prone hip extension.

Bandpass filter was set to 10 Hz to 450 Hz for analysis and 60 Hz that could affect the data were notched filter. To standardize the activity potential of each muscle, the maximal isometric contraction (MVIC) was used, and the bare-handed muscular position for maximum isometric contractions was used by Kendall et al.¹³⁾ PHE measurement time was averaged over the remaining 3 seconds, excluding the first and last signal 1 second of the 5 second period, to reduce the error, and analyzed with the root mean square (RMS). The unit of measure of muscle conduction was recorded as uV. In order to avoid this, 60 seconds of rest were provided at the end of each experiment, as the fatigue accumulated in the muscles during the measurement may have an important effect on the measurement data. PHE and ADIM PHE used sealed envelopes for randomizing, and all experiments were repeated 3 times.

The center of the cuff was placed in the bellybutton and the terminal area was placed over the anterior superior iliac spine, where ADIM was instructed to dilate pressure bio-feedback and then place it under the targets' stomach to draw the lower abdominal muscles softly. The pressure gauge is set to 70 mmHg. Then, hip extension while maintaining the posture at 60 mmHg.

Data processing collected through this study was calculated and compared with the mean and standard deviation for each variable using the commercial statistics program, SPSS ver. 20.0 for Window. The Shapiro-Wilks test was performed to verify the normality of the variables. As a result, the paired t-test was conducted to satisfy the normality. For muscle activity, paired t-tests were used to check the difference between PHE and the back muscle chain activity of ADIM PHE. Set up $p < 0.05$ for the significant level (α).

RESULTS

The contralateral latissimus dorsi muscle, the ipsilateral gluteus maximus showed higher activity at the ADIM PHE ($p < 0.05$), the ipsilateral erector spinae and the biceps muscle of thigh displayed lower activity at the ADIM PHE contraction ($p < 0.05$) (Table 2).

DISCUSSION

Sahrmann³⁾ said the muscles around the hip joint are the pelvis and biomechanical chains, which affect the lumbar spine through changes in the movement of the pelvis due to muscle shortening and weakening. Spinal muscle and gluteus maximus connected via thoracolumbar fascia work. Simultaneously in a study of peripheral muscle activity between back pain patients and normal people during interstitial flexion with muscle conduction. However, back pain patients experience a significant disruption in muscle interaction compared to normal people, slowing down gluteus maximus activities¹⁴⁾.

As the importance of gluteus maximus selective muscle strengthening method has grown, various studies have been conducted, and PHE studies have been actively conducted for the stability of patients with lower limb joint pain or back pain. However, none of the PHE studied so far have demonstrated the back muscle sling activity according to the activity of gluteus maximus. Views in this study on how PHE affects the back muscle sling activity in ADIM contraction that may change the activity of gluteus maximus, significantly increasing the activity of the dominant gluteus maximus and the opposite latissimus dorsi muscle in ADIM contraction ($p < 0.05$), and significantly decreasing the activity of the dominant erector spinae muscles and biceps muscle of thigh ($p < 0.05$).

This result, an anterior tilt occurs in the pelvis when the erector spinae muscles contracts. ADIM activates multifidus muscles soft inflatable contraction and muscle transvers abdominal, enabling muscles around the spine to perform normal functions and the spine to receive stable support, enabling smooth movement. This regulates the forward shear and flexion and also contributes to the stability of the spine through the waist pressure^{3, 15, 16)}.

In Kim et al.'s study¹⁷⁾, internal and external oblique abdominal muscle and the hip joint control the high joints by supporting and fixing the trunk while actively raising the hip extension. Thus, ADIM reduces the activity of erector spinae muscles,

Table 2. Activity in the muscles of the posterior oblique sling (%MVIC) during PHE and ADIM PHE (N=20)

Muscle	Mean %MVIC(SD)	
	PHE	ADIM PHE
CLD	16.74 ± 6.03*	21.74 ± 8.11*
IES	7.94 ± 4.40*	5.91 ± 3.29*
IGM	20.01 ± 10.11*	31.31 ± 9.54*
IBF	50.43 ± 11.80*	21.78 ± 8.96*

CLD: contralateral latissimus; IES: ipsilateral erector spinae; IGM: ipsilateral gluteus maximus; IBF: ipsilateral biceps femoris; PHE: prone hip extension; ADIM PHE: abdominal draw-in maneuver prone hip extension.

* $p < 0.05$.

which helps prevent unnecessary anterior tilt of pelvis during PHE and maintains proper alignment¹⁸⁾.

Among PHE, ADIM was reported to significantly increase the activity of gluteus maximus and decrease the biceps muscle of thigh activity of erector spinae muscles, which is consistent with the results of this study⁸⁾.

Vlemming et al.¹⁹⁾ said that the latissimus dorsi muscle and gluteus maximus on the opposite side of the muscles of the back muscle sling are connected to each other by thoracolumbar fascia, so the load is transferred across the center of the body to provide stability to the lumbar pelvis. Muscle and bone can be between available to the tension and fascia a contraction of muscles in the trunk and as an outward of fascia to produce power through connectivity system. The movement, as well to hook up multiple muscles work together to help. Thus, some muscles are connected to the same fascia, which can affect more than one area of function¹⁾.

The above results determined that ADIM shrinkage prevents anterior tilt, thereby reducing excessive activity of the biceps muscle of thigh activity and the erector spinae muscles, increasing gluteus maximus activity at the same time as local muscle contraction, resulting in increased activity of the opposite latissimus dorsi muscle through connection of thoracolumbar fascia. Thus, for patients with ceiling joint dysfunction, ADIM PHE is a good exercise method with selective back muscle-sling exercise programs.

There are several limitations to this study. First, only healthy targets were involved in this study. Second, no research has been conducted on the continuation of the effects. Finally, examined only the back muscle sling activity through ADIM contraction.

Conflict of interest

None.

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