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Isometric hip abduction using a Thera-Band alters gluteus maximus muscle activity and the anterior pelvic tilt angle during bridging exercise

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ABSTRACT

The purpose of this study was to investigate the effects of bridging with isometric hip abduction (IHA) using the Thera-Band on gluteus maximus (GM), hamstring (HAM), and erector spinae (ES) muscle activity; GM/HAM and GM/ES ratios; and the anterior pelvic tilt angle in healthy subjects. Twenty-one subjects participated in this study. Surface EMG was used to collect EMG data of GM, HAM, and ES muscle activities, and Image J software was used to measure anterior pelvic tilt angle. A paired *t*-test was used to compare GM, HAM, and ES muscle activity; the GM/HAM and GM/ES ratios; and the anterior pelvic tilt angle with and without IHA during the bridging exercise. GM muscle activity increased significantly and the anterior pelvic tilt angle decreased significantly during bridging with IHA using the Thera-Band ($p < 0.05$). However, there were no significant differences in the activity of the HAM and ES and the GM/HAM and GM/ES ratios between bridging with and without IHA ($p > 0.05$). The results of this study suggest that bridging with IHA using the Thera-Band can be implemented as an effective method to facilitate GM muscle activity and reduce the anterior pelvic tilt angle.

1. Introduction

The gluteus maximus (GM) is one of the largest and strongest muscles in the body. The GM originates from the posterior sacrum and coccyx as well as the posterior gluteal line of the ilium and inserts on the iliotibial tract and gluteal tuberosity of the femur (Frank and Netter, 1987). The GM is a powerful extensor and external rotator of the hip, and the superior part of the GM acts as a hip abductor because muscle fibers in the GM are directed downward and outward (Frank and Netter, 1987; Long et al., 1993). Hip extensors, especially the GM, are important for many functional activities of daily living such as moving from sitting to standing, climbing stairs, and maintaining an upright posture during walking (Winter, 1991). Because the direction of the GM muscle fibers, especially deep sacral fibers of the GM, are perpendicular to the sacroiliac (SI) joint, GM contraction improves SI joint stability and plays a part in force transmission from the lower extremity to the pelvis during ambulation (Hossain and Nokes, 2005; Leinonen et al., 2000; Mooney et al., 2001).

However, the GM is frequently weak and lengthened because many people spend a great amount of time remaining seated (Sahrmann, 2002). Decreased activity of the GM is one cause of low back pain (LBP) and results in SI joint instability and dysfunction (van Wingerden et al., 2004). In addition, hamstring (HAM) tightness can be observed as a compensatory mechanism for a weak GM (Massoud Arab et al., 2011; van Wingerden et al., 2004). Also, excessive anterior pelvic tilt, lumbar lordosis with dominant erector spinae (ES), and lumbar rotation occur in place of a weak GM or delayed GM activation during hip extension (Chaitow, 1996; Sahrmann, 2002).

Bridging exercises are the most commonly used by people with weak hip extensors and trunk muscles in physical therapy programs. However, bridging exercises are associated with a risk of dominant HAM and ES activity and excessive anterior pelvic tilt as a compensation for GM weakness regardless of the type of bridging exercise performed. Therefore, bridging exercise with isometric hip abduction (IHA) using a Thera-Band (Hygenic Corp., Akron, OH, USA) was devised in this study. No previous studies have compared GM with HAM and ES muscle activity and pelvic kinematics during bridging with IHA using the Thera-Band. Thus, the purpose of this study was to investigate the effects of bridging

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with IHA using the Thera-Band on GM, HAM, and ES muscle activity; GM/HAM and GM/ES ratios; and the anterior pelvic tilt angle in healthy subjects. It was hypothesized that bridging with IHA using the Thera-Band would result in increased GM muscle activity, increased GM/HAM and GM/ES ratios, and a decreased anterior pelvic tilt angle.

2. Methods

2.1. Subjects

A power analysis was performed with G*power software ver. 3.1.2 (Franz Faul, University of Kiel, Kiel, Germany) using the results of a pilot study involving five subjects. The calculation of sample size was carried out with a power of 0.80, alpha level of 0.05, and effect size of 0.89. This provided a necessary sample size of ten subjects for this study. Twenty-one healthy subjects (6 males, 15 females) were recruited from a university population (age = 22.5 ± 1.0 years, height = 165.3 ± 7.1 cm, weight = 57.5 ± 8.7 kg, and body mass index = 20.9 ± 1.8 kg/m^2).

The exclusion criteria were: (1) limitations in range of motion of the bilateral hip, knee, and ankle joints; (2) a history of LBP or lower extremity dysfunctions such as iliotibial band friction syndrome, patellofemoral pain syndrome, anterior cruciate ligament sprains, or chronic ankle instability (Cichanowski et al., 2007; Fredericson et al., 2000; Friel et al., 2006; Hewett et al., 2006; Ireland et al., 2003) in the past 12 months; (3) iliopsoas, rectus femoris, or tensor fasciae latae tightness as evidenced by the Thomas test, Ely's test, or modified Ober's test, respectively (Kendall et al., 2005; Magee, 2007); and (4) lumbopelvic instability demonstrated by performing the active straight leg raising test with a pressure biofeedback unit (Liebenson, 2004; Mens et al., 1999).

Prior to collecting data, the examiner informed the subjects of the study procedures and each subject completed an informed consent form. The study protocol was approved by the Yonsei University Wonju Institutional Review Board.

2.2. Exercise procedures

Subjects underwent a familiarization period of approximately 20 min to achieve a proper exercise performance capability. When subjects failed to perform the standardized position and maintain the position during the exercise period, data collection was immediately stopped. Subjects performed two conditions (with IHA and without IHA) of the same bridging exercise twice and maintained each position for 5-s. Bridging without IHA was followed by bridging with IHA to minimize the carry over or learning effect (Park et al., 2013). A 5-min rest between the two conditions and a 1-min rest between every two trials was given to avoid muscle fatigue.

2.2.1. Bridging without isometric hip abduction

The subjects were placed in a supine position. Both knees were flexed at 90°, the feet were hip-width apart while resting on the floor, and the toes were facing forward. The arms were crossed over the chest to minimize arm support (Fig. 1). Two plastic poles were placed vertically along the lateral aspect of the bilateral knee joint to maintain hip abduction of 30°. A wooden target bar was placed at the height of the middle point of the thigh between the greater trochanter and femoral condyle when the trunk, pelvis, and thigh were aligned in a straight line (hip extension of 0°). A universal goniometer was used for knee and hip angle measurements. The subject was instructed to lift his pelvis comfortably at a self-selected speed while maintaining contact between the lateral aspects of the bilateral knee joint and vertically placed plastic poles. When both thighs touched the wooden target bar during bridging, the subject was asked not to lift his pelvis further and to hold the bridging position for 5-s without pelvic or thigh movement (Fig. 2).

2.2.2. Bridging with isometric hip abduction

Bridging with IHA followed the same procedure as bridging without IHA, with the exception of the application of a blue-colored Thera-Band, which is recommended by the manufacturer for an intermediate or advanced workout level. The Thera-Band was wrapped around both thighs just proximal to the knees, providing consistent resistance to IHA. Tension was controlled by lengthening or shortening the Thera-Band. The tension in the Thera-Band was determined when the subject was able to perform more than ten repetitions of hip abduction of 30° in hook-lying position using the Thera-Band (Decker et al., 1999; Park et al., 2013) (Fig. 3).

Fig. 1. Starting position of bridging exercise.

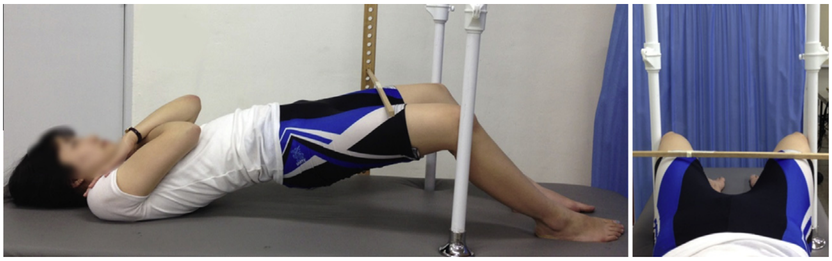

Fig. 2. Bridging without isometric hip abduction.