Comparison of Hip Stabilization Muscle Use during Neutral Sit to Stand and Sit to Stand Involving Isometric Hip Abduction in Elderly Females

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Abstract. [Purpose] The purpose of this study was to compare the activation of the gluteus medius (Gmed), rectus femoris (RF), and biceps femoris (BF) muscles during neutral (N) sit to stand (STS) and STS involving hip abduction (ABD) in elderly females. [Subjects] We recruited 16 healthy elderly females with no pain in the knee joint or any other orthopedic problems of the lower limbs. [Methods] The activities of the dominant lower extremity muscles were measured using a wireless electromyography (EMG) system. Subjects then undertook a total of six STS trials: three for neutral STS and three for STS involving hip abduction. [Results] In the pre-TO phase, activation of the RF muscle was significantly increased during hip ABD. In the post-TO phase during hip ABD, Gmed muscle activation was significantly increased, and RF muscle activation was significantly decreased. [Conclusion] This study suggests that STS involving hip ABD is more effective in decreasing Gmed activation and reducing RF effort in elderly females.

Key words: Sit to stand, Hip abduction, Hip stabilization muscles

INTRODUCTION

The sit to stand (STS) movement is one of the most common and necessary for every-day life movements and is performed frequently by healthy elderly individuals (between 46 and 96 times per day)1-2). Dawson et al. reported higher rates of hip and knee pain in females compared with males in a group between 65 and 74 years of age3). Owing to age-associated reductions in lower extremity strength and functional ability, the STS movement may be particularly challenging for the elderly4, 5). Previous studies have examined muscle activity during squat exercises involving hip abduction. Felício et al. reported that squats involving hip abduction entail more activation of the gluteus medius (Gmed)6). Hip stabilization muscles that play a key role in stabilization include the gluteus medius, glutleus maximus, piriformis and deep core muscles). Understanding how to properly perform STS, in order to promote greater activation of the hip stabilizers, is especially important because weakness of the pelvic stabilizers is associated with an increased likelihood of falls in the elderly. Therefore, the purpose of the present study was to compare the electromyographic activity of the hip stabilizers during neutral STS and STS associated with isometric hip abduction in elderly females.

SUBJECTS AND METHODS

Sixteen healthy elderly female subjects (67.75 ± 1.61 years, 153.5 ± 6.61 cm, 54.46 ± 7.22 kg) participated in this study. Subjects had no impairments in lower-extremity or weight-bearing movements, as confirmed by a physician. All subjects were devoid of muscular pathology and could stand up and walk independently. This study was approved by the Inje University Faculty of Health Science Human Ethics Committee, and subjects provided written informed consent prior to participating. The activities of the dominant lower extremity muscles were measured using a wireless electromyography (EMG) system (Delsys, Inc., Boston, MA, USA) with surface electrodes fixed at an interelectrode distance of 10 mm. EMG surface electrodes were placed over the muscle bellies of the dominant-side gluteus medius (Gmed), rectus femoris (RF), and biceps femoris (BF) muscles. The EMG data expressed the entire STS task as a percentage of maximum voluntary isometric contraction.

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total of six STS trials: three STS trials involving hip abduction (ABD) and three neutral (N) STS trials in a random order. Subjects were instructed to face forward and stand up from the seat at a comfortable speed. STS movements involving hip ABD were performed in the same position as the N STS movements but with the MIVC of the hip ABD being additionally resisted by a nonelastic band that was adjustable with Velcro® and positioned next to the lateral femoral epicondyle. Following the STS movement, subjects were instructed to stand still for 5 s. STS start and end times were determined via a marker attached to the right acromion. Statistical analysis was performed using a paired t-test with SPSS for Windows (Version 18.0; SPSS Inc., Chicago IL, USA) with the level of statistical significance set at p < 0.05.

RESULTS

In the pre-TO phase, Gmed muscle activation was not significantly different between the N STS and STS involving hip ABD movements (N, 23.2 ± 8.1%; ABD, 24.9 ± 9.5%)(p > 0.05). Activation of the RF muscle was increased significantly in STS involving hip ABD (17.9 ± 14.1%) compared with N STS (12.5 ± 7.8%; p < 0.05), but there was no difference in BF muscle activation during the two movements (p > 0.05; N, 15.5 ± 19.2%; ABD, 9.6 ± 5.1%). In the post-TO phase, Gmed muscle activation was increased significantly during STS involving hip ABD (53.6 ± 24.7%) compared with N STS (45.8 ± 23.3%; p < 0.05). RF muscle activation decreased significantly in STS involving hip ABD (53.6 ± 24.7%) compared with N STS (35.3 ± 19.4%; p < 0.05), but there was no significant difference in BF muscle activation during the two movements (p > 0.05; N, 36.0 ± 16.3%; ABD, 32.1 ± 17.8%).

DISCUSSION

In the present study, Gmed activity in STS involving hip ABD was significantly greater (by 16.92%) compared with N STS in the post-TO phase. The gluteus medius acts to stabilize the hip in both the frontal and transverse planes. Weakness of the hip abductors in elderly persons is a potentially important contributor to lateral instability and is associated with diminished physical performance⁷. Heo et al. reported that the wall-squat exercise, which involves isometric hip abduction, engenders increased activation of both the middle and posterior fibers of the Gmed⁸. This is surprising considering the functional importance of the hip abductor for frontal plane balance control and, potentially, fall prevention. The use of second-line isometric resistance at a secondary joint can facilitate motor synergy across multiple joints and several planes of motion. Conversely, we found that RF activity was increased during STS involving hip ABD compared with during N STS in the pre-TO phase. RF activity in the abduction condition was increased significantly (by 42.69%) compared with the neutral condition in the pre-TO phase. Rodosky reported that the pre-TO phase is characterized by forward flexion of the trunk associated with increased hip flexion⁹. During the pre-TO phase, the knee angle changes slightly from its initial flexed position, and the thigh moves forward and upward from the chair. In the present study, hip abduction affected the increase in hip extension, so it would likely interfere with forward movement of the body. To lift the body from a seat, it is necessary to produce more hip flexion. Therefore, the increased RF activity identified in this study might help to produce flexion at the hip during the STS task. Moreover, the RF activity in STS involving hip ABD decreased significantly (by 12.41%) compared with that in the neutral condition in the post-TO phase. These results suggest that a decreased average level of RF muscle activity necessitates less muscular effort during the STS movement, thereby facilitating the STS process, particularly in elderly females.

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