



Original Article

## Changes in isolation ratios of the trunk muscles during hip adduction

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**Abstract.** [Purpose] The purpose of this study was to compare the changes in isolation ratios of the trunk muscles during hip adduction. [Subjects and Methods] In total, 15 males aged 27–35 years were recruited for the present study. Electromyography data of the external oblique, internal oblique, and erector spinae muscles were collected during hip adduction exercise. [Results] With respect to the internal oblique muscles, the isolation ratio during hip adduction was significantly higher than during no adduction. With respect to the external oblique muscles, the isolation ratio during hip adduction was significantly lower than during no adduction. [Conclusion] Therefore, hip adduction would be a proper exercise for isolated training of the internal oblique muscles, rather than the external oblique muscles, for trunk stability.

**Key words** : External oblique, Isolation ratio, Trunk stability

(This article was submitted Apr. 29, 2017, and was accepted Jun. 8, 2017)

### INTRODUCTION

Previous studies have shown the effects of hip adduction exercises on increasing the activation of the lower extremities, pelvis, and trunk muscles<sup>1-3)</sup>. However, it is natural that the activation of neighboring muscles would increase according to hip adduction loading<sup>3)</sup>. Therefore, clinicians believe that changes in the proportional contribution of muscles to exercise is more important than increased muscle activity by loading<sup>3-5)</sup>. The isolated contraction ratio is calculated as the ratio of co-activated muscles and indicates the proportional contribution of any given muscle to a specific motion<sup>5)</sup>. Therefore, we investigated the isolated contraction ratio using the following formula: isolation ratio = (muscle A or B or C / [muscle A + muscle B + muscle C]) × 100%. Contraction of the hip adductor muscle synergistically activated pelvic floor muscles, which were activated by contraction of the abdominal muscles<sup>2)</sup>. The purpose of this study was to compare the changes in isolation ratios of the trunk muscles during hip adduction.

### SUBJECTS AND METHODS

In total, 15 males aged 27–35 years were recruited for the present study. The body mass and height of the subjects were  $60.7 \pm 8.5$  kg (mean  $\pm$  standard deviation [SD]) and  $167.6 \pm 10.5$  cm, respectively. Subjects with conditions that may have affected the mobility of the spine, and those suffering from an injury or pain or neurological deficits in the upper and/or lower extremities during the previous year were excluded from the study. The study purpose and methods were explained to each subject, who provided informed consent according to the principles of the Declaration of Helsinki before participating. Electromyography data of the external oblique (EO), internal oblique (IO), and L4–L5 erector spinae (ES) muscles were collected using a Biopac MP100WSW (Biopac System, Santa Barbara, CA, USA) data acquisition system. To measure EO activity, the first electrode was placed at the intersection of a line lateral to the umbilicus and superior to the anterior superior iliac spine

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(ASIS), with the second electrode arranged so that the bipolar configuration was approximately 45° to the horizontal. The IO muscles are located approximately 2 cm inferior and medial to the ASIS (the muscle fibers of the transversus abdominus and IO muscles are blended at this site; therefore, a distinction between muscle signals cannot be determined at this location). The L4–L5 erector spinae muscles are located at the level of L4–5, approximately 3 cm lateral to the spinous process and arranged along the longitudinal axis. Amplitude was normalized to the maximum voluntary isometric contraction. The isolation ratio of each muscle was calculated using the following formula: isolation ratio (%) = IO or EO or ES / (IO + EO + ES) × 100%. A digital air pressure sensor (AP series pressure sensor, Keyence, Japan) was directly connected to an air cushion and calibrated to zero at no hip adduction. The air cushion was placed between the thighs. Subjects performed mild hip adduction (air pressure: 0.2 Mpa) with the visual feedback device for hip adduction in a seated position. The Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) was used for all statistical analyses. The paired t-test was used to analyze the significance of differences between the isolation ratios. The level of statistical significance,  $\alpha$ , was set at 0.05.

## RESULTS

With respect to the IO muscles, the isolation ratio during hip adduction ( $36.6 \pm 6.1\%$ ) was significantly higher than during no adduction ( $30.6 \pm 5.4\%$ ) ( $p < 0.05$ ). With respect to the EO muscles, the isolation ratio during hip adduction ( $34.3 \pm 5.8\%$ ) was significantly lower than during no adduction ( $38.5 \pm 7.9\%$ ) ( $p < 0.05$ ). With respect to the ES muscles, the isolation ratio during hip adduction ( $29.3 \pm 6.1\%$ ) did not differ significantly compared to no adduction ( $30.8 \pm 7.1\%$ ) ( $p > 0.05$ ).

## DISCUSSION

A previous study investigated the influence of a resistive band on the muscles involved in leg adduction performed in a variety of positions and showed that hip adduction with a resistive device increased trunk stability<sup>1</sup>. The general goal of hip adduction training is core stability<sup>3</sup>. We compared the changes in isolation ratios of the trunk muscles during hip adduction. The isolation ratio of IO muscles during hip adduction was significantly higher than during no adduction, whereas those of EO muscles were significantly lower. Co-activation of the hip adductor muscles, pelvic floor muscles, and internal abdominal muscles is necessary for intra-abdominal pressure (IAP), which reinforces the power of the multifidus and contributes to spinal stability<sup>2, 4</sup>. Therefore, increasing the muscular strength of this structure may reduce the incidence of spinal injuries<sup>3, 4</sup>. Of the abdominal muscles, the internal and transverse abdominal muscles have been identified as the muscles most closely associated with an increase in intra-abdominal pressure, and the combined action of these core muscles may be related to an increase in IAP<sup>3, 4</sup>. Our study revealed an increased proportional contribution of IO muscles and a decreased proportional contribution of EO muscles to hip adduction exercises. Crow et al. suggested that isolated muscle training is the best mode of exercise to achieve therapeutic exercise training effects<sup>6</sup>. Therefore, hip adduction would be a proper exercise for isolated training of the IO muscles, rather than the EO muscles, for trunk stability.

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