



Original research

Comparison of gluteus maximus and hamstring electromyographic activity and lumbopelvic motion during three different prone hip extension exercises in healthy volunteers



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ARTICLE INFO

Article history:

Received 6 June 2015

Received in revised form

15 February 2016

Accepted 18 March 2016

Keywords:

Gluteus maximus

Prone hip extension

Lumbopelvic stability

ABSTRACT

Objective: To compare the surface electromyography (EMG) amplitude of the hip joint, including the gluteus maximus (GM), biceps femoris (BF), and semitendinosus (ST) muscles generated by three different exercises: prone hip extension (PHE), prone table hip extension (PTHE), and prone table hip extension with 90° knee flexion (PTHEK), with compensatory pelvic motions.

Design: Repeated-measure within-subject intervention.

Participants: Sixteen-healthy males (mean age = 23.4 ± 2.2 years).

Main outcome measures: EMG was used to collect EMG signals from the GM, erector spinae (ES), BF, and ST muscles. Furthermore an electromagnetic tracking motion analysis was also performed to measure the compensations.

Results: EMG amplitude differed significantly among the three conditions (PHE vs. PTHE vs. PTHEK) ($p < 0.05$). The mean GM muscle activity increased significantly during the PTHEK (70.93% and 13.75% increases in %MVIC compared with the PHE and PTHE, respectively) ($p < 0.01$). However, there was no significant difference in the kinematic data for rotation or anterior tilting angle of the pelvis among the three conditions ($p > 0.05$).

Conclusions: These results suggest that the PTHEK can be recommended as an effective method to strengthen the GM muscle without increased BF or ES muscle activities and without compensatory pelvic motions.

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1. Introduction

Active prone hip extension (PHE) is a strengthening exercise for individuals with some form of weakness in their hip joint muscles (Tateuchi, Taniguchi, Mori, & Ichihashi, 2012). Furthermore, measuring the stability of the lumbopelvic region can be accomplished through PHE (Janda, 1996; Sahrman, 2002). In addition, previous studies have stated that PHE can be used to evaluate lumbo-pelvic-hip joint muscle activation (Ebrall, 2004; Greenman, 2003; Hertling and Kessler, 2006; Janda, 1996). Sahrman (2002) reported that individuals with lumbopelvic instability have limitations in controlling excessive extension and rotation of the

lumbar spine and anterior tilt and rotation of the pelvis during PHE. Interestingly, over-activity of the erector spinae and hamstring muscles, along with a decreased activation of the gluteus maximus (GM) muscle, has been explained as being due to a change in the activation pattern in these muscles, which can cause movement dysfunction (Janda, 1996; Sahrman, 2002).

The PHE exercise is one of the primary conventional interventions in rehabilitation to strengthen the GM (Cappozzo, Felici, Figura, & Gazzani, 1985; Wilson, Ferris, Heckler, Maitland, & Taylor, 2005). Kendall, McCreary, and Provance (2005) recommended PHE incorporating a minimum knee flexion of 90° with resistance against the lower part of the posterior thigh for promoting GM strength. However, a modified test of GM strength is used for individuals possessing low back muscle (*i.e.* extensor) weakness and/or hip flexor tightness. Specifically, individuals lie on a table with their trunk in the prone position and legs hanging over the end of the table (Kendall et al., 2005). For example, Kang, Jeon,

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