Manual Therapy 20 (2015) 412–419

Contents lists available at ScienceDirect

Manual Therapy

journal homepage: www.elsevier.com/math

Original article

Effects of external pelvic compression on electromyographic activity of the hamstring muscles during unipedal stance in sportsmen with and without hamstring injuries

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ARTICLE INFO

Article history:
Received 14 February 2014
Received in revised form
9 July 2014
Accepted 16 October 2014

Keywords:
Electromyography
Hamstring injury
Pelvic compression belt
Unipedal stance

ABSTRACT

There is some evidence that hamstring function can be influenced by interventions focusing on the pelvis via an anatomic and neurophysiologic link between these two segments. Previous research demonstrated increased electromyographic activity from injured hamstrings during transition from bipedal to unipedal stance (BUS). The aim of this study was to investigate the effects of a pelvic compression belt (PCB) on electromyographic activity of selected muscles during BUS in sportsmen with and without hamstring injury. Electromyographic amplitudes (normalised to maximum voluntary isometric contraction [MVIC]) of the hamstrings, gluteus maximus, gluteus medius and lumbar multifidus were obtained during BUS from 20 hamstring-injured participants (both sides) and 30 healthy participants (one side, randomly selected). There was an increase in biceps femoris (by 1.23 ± 2.87 %MVIC; $p = 0.027$) and gluteus maximus (by 0.63 ± 1.13 %MVIC; $p = 0.023$) electromyographic activity for the hamstring-injured side but no significant differences other than a decrease in multifidus activity (by 1.36 ± 2.92 %MVIC; $p = 0.023$) were evident for healthy participants while wearing the PCB. However, the effect sizes for these findings were small. Wearing the PCB did not significantly change electromyographic activity of other muscles in either participant group ($p > 0.050$). Moreover, the magnitude of change induced by the PCB was not significantly different between groups ($p > 0.050$) for the investigated muscles. Thus, application of a PCB to decrease electromyographic activity of injured hamstrings during BUS is likely to have little effect. Similar research is warranted in participants with acute hamstring injury.

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1. Introduction

Hamstring injuries are common in sports that involve high-velocity running or extensive lengthening of the hamstring muscles (Askling et al., 2012) and it has been suggested that loss of optimal neuromotor control may contribute towards occurrence and recurrence of these injuries (Cameron et al., 2003; Sole et al., 2008). An inherent anatomic link exists between the hamstrings and the sacroiliac joint (SIJ) via the sacrotuberous ligament (Vleeming et al., 1989; Woodley and Mercer, 2005) and it is through this structural pathway that biomechanical and neuromotor alterations of lumbopelvic function is thought to influence hamstring function (Mason et al., 2007; Panayi, 2010). Clinical examination of the SIJ often includes assessment of transition from bipedal to unipedal stance (BUS) using Gillet's test (Potter and Rothstein, 1985; Sturesson et al., 2000). Variations of this technique have also been implemented in the assessment of neuromotor control of lumbopelvic and/or lower limb muscles in patients with SIJ, pelvic, groin and lower limb injuries (Hungerford et al., 2003; van Deun et al., 2007; Morrissey et al., 2012; Sole et al., 2012; Jung et al., 2013). Transitions from BUS are fundamental for the initiation of gait (Rogers and Pai, 1993) and to perform sporting techniques such as kicking, shooting or passing a ball (Paillard et al., 2006). Investigations of BUS are useful for examining motor control of the lumbopelvic and hamstring muscles as this task requires pelvic stabilisation and is functionally relevant to walking and climbing stairs (Morrissey et al., 2012).

A recent systematic review on the effects of external pelvic compression reported moderate evidence to support the role of

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http://dx.doi.org/10.1016/j.math.2014.10.011
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pelvic compression in altering electromyographic (EMG) activity of muscles associated with the pelvis (Arumugam et al., 2012b). More recently, Jung et al. (2013) reported that wearing a pelvic compression belt (PCB) decreases biceps femoris (BF) activity and increases gluteus maximus (GMa) activity during BUS in participants with and without SIJ pain. A decrease in BF EMG has also been demonstrated during standing (Snijders et al., 1998) and walking (Hu et al., 2010) with application of a PCB in healthy individuals. In addition, Hu et al. (2010) documented an increase in GMa activity during walking in healthy women, which might indicate that the need for the BF to extend the hip could be compensated by increased recruitment of the GMa with the PCB.

Previous studies have reported abnormal recruitment patterns, evident by earlier EMG onset and/or increased amplitudes, of the BF on the affected side during BUS in patients with unilateral SIJ pain (Hungerford et al., 2003) and with hamstring injuries (Sole, 2008; Sole et al., 2012). Increased (aberrant) recruitment of injured hamstrings might predispose to further (re)injury (Sole et al., 2008). It is unknown whether application of a PCB has an effect on EMG of injured hamstrings; however, various hypothetical mechanisms underpinning the effects of a PCB on hamstring function have been proposed (Arumugam et al., 2012a). We have recently reported that application of the PCB increased isokinetic eccentric muscle strength in the outer range of movement for participants with hamstring injuries, suggesting that application of such a belt had effects on neuromotor control of the hamstrings (Arumugam et al., 2014). The aim of the current study was to investigate changes in recruitment patterns of the hamstrings, glutei and lumbar multifidi (MF) with application of a PCB during BUS in the same group of sportsmen with and without recent hamstring injuries. We hypothesised that application of the PCB would reduce EMG activity of the hamstrings in both study groups (Arumugam et al., 2012b).

2. Methods

2.1. Study design and participants

A cross-over design was used in which the order of belt conditions (PCB vs. no PCB) was randomised. Ethical approval was received from the University of Otago Human Ethics Committee (Reference − 11/115). All participants provided written informed consent before participating in the study. Data collection was conducted at the Biomechanics laboratory, School of Physiotherapy, University of Otago, Dunedin, New Zealand.

Participants were recruited from the University, local sports clubs and physiotherapy clinics using posters, flyers and emails. The eligibility criteria (Sole et al., 2012) are summarised in Table 1. The same group of sportsmen also participated in a study investigating the effects of the application of the PCB during isokinetic strength testing (Arumugam et al., 2014) and walking. Data for weight-bearing tasks (BUS followed by walking) were collected during the first session while the isokinetic task was performed during a second session within one week (Arumugam, 2014). Participants underwent musculoskeletal screening to confirm their eligibility. Anthropometric measurements were recorded and footedness was determined based on self-declared leg preference when kicking a ball (Teixeira and Teixeira, 2008). Bilateral hamstring flexibility was assessed simultaneously using the sit-and-reach test (Liemohn et al., 1994).

2.2. Procedures

Data were collected from one side (left/right) for the healthy participants and both sides for the hamstring-injured participants. The choice of leg to be tested for the healthy participants and the order of testing for the hamstring-injured participants were randomised using computer-generated numbers list.

Standard guidelines recommended by the Surface Electromyography for the Non-Invasive Assessment of Muscles (SENIAM) committee for skin preparation and electrode placement were followed (Hermens et al., 1999, 2000). Two Ag/AgCl surface electrodes were placed on the targeted site on each muscle at an inter-electrode distance of 2 cm. The ground electrode was placed on the L2 spinous process. Data were collected only when skin impedance, measured with a multimeter (Tequipment.NET™, NJ), was less than 10 KΩ (Konrad, 2005) and negligible crosstalk was observed during voluntary muscle contraction. A 16 channel Noraxon Telemyo™ 2400 T G2 system (Noraxon Inc., AZ) with MyoResearch XP Master-Edition software™ V1.06.54 was used to record and process EMG data.

Conventional manual muscle testing positions (Daniels et al., 2007) were adopted to record maximum voluntary of isometric contraction (MVIC) of the MF, GMa, gluteus medius, and hamstrings. A total of three MVIC trials were performed for each muscle and participants were encouraged verbally to produce a maximal contraction. Each trial lasted for 5 s and a rest period of 1 min was allowed between trials. EMG data were recorded for 3 s of each trial after the EMG signals reached a steady state following the first second.

Table 1
Eligibility criteria for recruiting participants.

Hamstring-injured group[a]	Healthy group
Inclusion criteria	
- An onset of pain in the posterior thigh while playing a sport (nonimpact) within the previous 12 months, but not less than a month	- No previous history of hamstring injury that was diagnosed and treated by a health professional
- The injury was severe enough to necessitate intervention from a health professional or prevent participation in at least one match or competition (Bennell et al., 1998; Orchard, 1998), and one week[b] of regular sports training (Brockett et al., 2004), within the previous 12 months	
- History of unilateral or bilateral, first-time or recurrent hamstring injuries	
Exclusion criteria	
- Trauma or pathology in the knee joint or lumbopelvic region within the last six months that was treated by a health professional or prevented involvement in at least one week of training sessions, a competition or match	
- Evidence of any neuromotor or musculoskeletal abnormality of the lumbopelvic region and/or the lower limb during clinical examination (Laslett et al., 2005; Laslett, 2008; Petty, 2011)	
- Ongoing musculoskeletal (lumbopelvic and/or lower limb), neurological, cardiorespiratory, inflammatory or other systemic disorder	

[a] Sportsmen were included based on their self-reported history of hamstring injury within the past 12 months as it is reported to be reliable (Gabbe et al., 2003).
[b] Based on the period of absence from sports participation, injury severity was classified as minor (≤7 days), moderate (8–21 days) or severe (>21 days) (Arnason et al., 2008).

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