Journal of Science and Medicine in Sport 18 (2015) 283–288

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

Effects of external pelvic compression on isokinetic strength of the thigh muscles in sportsmen with and without hamstring injuries

Ashokan Arumugam[a,*], Stephan Milosavljevic[b], Stephanie Woodley[c], Gisela Sole[a]

[a] School of Physiotherapy, University of Otago, New Zealand
[b] School of Physical Therapy, University of Saskatchewan, Canada
[c] Department of Anatomy, University of Otago, New Zealand

ARTICLE INFO

Article history:
Received 30 December 2013
Received in revised form 7 May 2014
Accepted 17 May 2014
Available online 23 May 2014

Keywords:
Athletic injury
Muscle strength dynamometer
Orthotic devices

ABSTRACT

Objectives: To investigate whether application of a pelvic compression belt affects isokinetic strength of the thigh muscles in sportsmen with and without hamstring injuries.
Design: Randomized crossover, cross-sectional.
Methods: Twenty sportsmen (age 22.0 ± 1.5 years) with hamstring injuries (hamstring-injured group) and 29 (age 23.5 ± 1.5 years) without hamstring injuries (control group) underwent isokinetic testing of the thigh muscles. Testing included five reciprocal concentric quadriceps and hamstring contractions, and five eccentric hamstring contractions at an angular velocity of 60°/s, with and without a pelvic compression belt in randomized order. The outcome measures were average torque normalized to bodyweight for terminal range eccentric hamstring contractions and peak torque normalized to bodyweight for concentric quadriceps, concentric hamstring and eccentric hamstring contractions.
Results: There was a significant increase in normalized average torque of eccentric hamstring contractions in the terminal range for both groups ($p \leq 0.044$) and normalized peak torque of eccentric hamstring contractions for injured hamstrings ($p = 0.025$) while wearing the pelvic compression belt. No significant changes were found for other torque variables. Injured hamstrings were weaker than the contralateral uninjured hamstrings during terminal range eccentric hamstring ($p = 0.040$), and concentric hamstring ($p = 0.020$) contractions recorded without the pelvic compression belt. However, no between-group differences were found for any of the investigated variables.
Conclusion: Wearing the pelvic compression belt appears to have a facilitatory effect on terminal range eccentric hamstring strength in sportsmen with and without hamstring injuries. Future investigations should ascertain whether there is a role for using a pelvic compression belt for rehabilitation of hamstring injuries.

1. Introduction

Hamstring injury is reported to most commonly occur in either the terminal stance[1] or swing phases[1,2] of sprinting, associated with eccentric loading and lengthening of this bi-articular muscle group. Injured hamstrings also exhibit decreased torque and electromyographic (EMG) activity in the terminal range of eccentric isokinetic contractions.[3] Assessment and rehabilitation of hamstring injuries include multi-factorial strategies including examination of hamstring neuromotor control and strength. Recent literature has also emphasized examination of lumbopelvic spine biomechanics and motor control as potential factors contributing to hamstring injury.[4] Moreover, an increase in isokinetic concentric peak torque of injured hamstrings following manipulation of the sacroiliac joint (SIJ) has been reported.[5] Anatomically, the proximal tendon of the biceps femoris (long head) is continuous in part with the sacrotuberous ligament.[6] Thus, there appears to be a functional relationship between the hamstring muscles and the lumbopelvic spine.

The use of a pelvic compression belt (PCB) is found to directly influence stability and mobility of the SIJ,[7] and also claimed to indirectly influence function of the hamstrings.[8] While application of a PCB appears to affect hamstring neuromotor control and strength,[7,8] these relationships need to be explored further. Weakness of injured hamstrings has been hypothetically linked to injury recurrence[9] and, if so, there may be some merit in examining the effects of external pelvic compression on

* Corresponding author.
E-mail addresses: ashokan.arumugam@otago.ac.nz, ashokanpt@gmail.com (A. Arumugam).

http://dx.doi.org/10.1016/j.jsams.2014.05.009
1440-2440/

hamstring neuromotor control as part of a multi-modal intervention plan.

According to a recent systematic review,[7] studies have investigated the effects of external pelvic compression on the isometric strength of muscles during a task (for example during lifting, and the active straight leg raise) or certain muscle groups (low back, hip adductor) in individuals with or without lumbopelvic dysfunction. There is some evidence that interventions (manipulation) directed at the SIJ/lumbopelvic joints can affect thigh muscle strength[5,10] supporting an argument for a neuromotor link between the pelvic and thigh regions. These putative structural and neuroreflexive links between the hamstrings, pelvis and lumbar spine provide a research focus to determine whether application of a pelvic compression belt (PCB) can alter the isokinetic strength of the thigh muscles in sportsmen with and without hamstring injuries.

2. Methods

A randomized cross-over experimental design was used and the study was conducted in the Mark Steptoe Laboratory of the School of Physiotherapy at the University of Otago. Ethical approval was granted by the University of Otago Human Ethics Committee (Reference no. 11/115) and written informed consent was obtained from all participants.

Participants aged between 18 and 35 years were recruited by email, word of mouth, and adverts displayed around the University. Sportsmen were included in the hamstring-injured group based on self-report of injury[3,11] if they had experienced an immediate onset of pain in the posterior aspect of the thigh while playing sport[12] within the previous 12 months, but not less than a month; the injury necessitated intervention from a health professional and prevented participation in at least one match or competition,[13] or at least one week of usual sports training,[14] within the previous 12 months. Unilateral or bilateral, first-time or recurrent hamstring injuries were eligible for inclusion. Sportsmen without any previously diagnosed hamstring injury were recruited for the control group. A known history of trauma/dysfunction in the lower limb (other than hamstring injury) or lumbopelvic region within the previous six months that required intervention by a health professional excluded potential participants from both groups. Further, those with any evidence of abnormal signs and symptoms (other than those related to hamstring injuries) during clinical examination of the lumbopelvic region and/or the lower limb were excluded. The ability of sportsmen to recall the history of injury within the previous 12 months has been reported to be valid[11] and, therefore, participants were recruited based on their self-declaration of history of hamstring injury.

Before isokinetic testing, anthropometric measurements (height, body mass and 4-point skin fold measures) were recorded. To estimate body fat percentage, skin fold measurements were taken using calipers (Slim Guide® caliper, Creative Health Products, MI) for the triceps, infrascapular, suprailiac and mid-thigh regions using standard guidelines.[15] The sit-and-reach test was used to assess bilateral hamstring flexibility.[16]

Isokinetic tests were performed under two conditions, with and without the PCB. Data were collected from both sides for the hamstring-injured participants and only one side (left or right) for the control participants. The leg to be tested and the order of test conditions (PCB vs. no PCB) were randomized using computer generated numbers.

The PCB (SI-brace neoprene-ADL-anatomisch; Rafys, The Netherlands) was applied just below the anterior superior iliac spines (Fig. 1),[7,17] and tightened maximally by the primary investigator (AA) without any discomfort to participants. The amount of PCB tension achieved during isokinetic tests was recorded using a load cell in a separate study on 10 healthy men. The mean PCB tension was found to be 63.43 (±9.90) N for reciprocal concentric quadriceps (ConQ) and concentric hamstrings (ConH) contractions, and 49.78 (±5.70) N for eccentric hamstring (EccH) contractions. Participants walked around the room between the conditions for at least 5 min[18] to provide an adequate wash-out effect.

Fig. 1. Position of the pelvic compression belt as used in the study.

A warm-up of 5 min of static cycling (60 rpm) was undertaken prior to testing. Participants were then seated on a Biodex™ system 3 pro isokinetic dynamometer (Biodex Medical systems, NY) with a trunk-hip angle of 100° (Supplementary Fig. 1). The mechanical axis of rotation of the dynamometer was aligned with the lateral femoral epicondyle, and the shin pad was placed about 2 cm above the medial malleolus. The effect of gravity on the leg was adjusted using the Biodex software after placing the knee between 25° and 30° of extension. Participants were familiarized with the dynamometer and a warm-up of the thigh muscles included a minimum of 10 sub-maximal contractions followed by two maximal concentric and eccentric contractions at 60°/s.[3] Five reciprocal ConQ and ConH maximal contractions were then performed at an angular velocity of 60°/s followed by five EccH contractions at 60°/s. The torque and velocity data were recorded at 200 Hz with the Biodex software (version 3.30), within a range of motion of 90° during each contraction: 0° of extension (starting position) to 90° of flexion (end position) for ConH, and 90° of flexion to 0° of extension for ConQ and EccH contractions. A rest period of 2 min was allowed between concentric and eccentric trials to minimize fatigue.[19]

Supplementary material related to this article can be found, in the online version, at doi:10.1016/j.jsams.2014.05.009.

Outcome measures included (gravity-corrected) peak torque (PT) normalized to bodyweight for ConQ, ConH and EccH contractions, average torque normalized to bodyweight for the terminal range of EccH contractions, and the functional torque ratio (PT EccH:PT ConQ). Further, the torque data of EccH contraction were analyzed from 85° to 5° knee flexion using a 50 ms epochs approach; the initial and terminal 5° were omitted because they are essentially non-isokinetic. The outer range (≈25–5° of knee extension) corresponded to the last six 50 ms epochs.[3] The average torque of the terminal movement quartile from five repetitions was normalized to bodyweight to allow comparison between the test conditions (PCB vs. no PCB). The obtained value was multiplied by 100 to ensure consistency with the results of the Biodex software.[20] As the knee joint angle can vary from 20° to 33° compared to