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The effect of motor control training on abdominal muscle contraction during simulated weight bearing in elite cricketers

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ABSTRACT

Objectives: To investigate whether motor control training alters automatic contraction of abdominal muscles in elite cricketers with low back pain (LBP) during performance of a simulated unilateral weight-bearing task.
Design: Clinical trial.
Methods: 26 male elite-cricketers attended a 13-week cricket training camp. Prior to the camp, participants were allocated to a LBP or asymptomatic group. Real-time ultrasound imaging was used to assess automatic abdominal muscle response to axial loading. During the camp, the LBP group performed a staged motor control training program. Following the camp, the automatic response of the abdominal muscles was re-assessed.
Results: At pre-camp assessment, when participants were axially loaded with 25% of their own body-weight, the LBP group showed a 15.5% thicker internal oblique (IO) muscle compared to the asymptomatic group ($p = 0.009$). The post-camp assessment showed that participants in the LBP group demonstrated less contraction of the IO muscle in response to axial loading compared with the asymptomatic group. A trend was found in the automatic recruitment pattern of the transversus abdominis ($p = 0.08$).
Conclusions: Motor control training normalized excessive contraction of abdominal muscles in response to a low load task. This may be a useful strategy for rehabilitation of cricketers with LBP.

1. Introduction

Low back pain (LBP) is common in athletes, despite their high levels of fitness. In Australian cricketers, lumbar stress fractures exact the greatest toll on cricketers in terms of missed playing time (Orchard, James, Kountouris, Blanch, Sims, & Orchard, 2011). While research has been conducted on risk factors such as bowling (Portus, Mason, Elliott, Pfitzner, & Done, 2004), physical characteristics of the individual (Dennis, Finch, & Farhart, 2005) and workload (Dennis, Finch, McIntosh, & Elliott, 2008), few studies have investigated the role of physical preparation such as motor control training of the lumbo-pelvic region on LBP in cricketers.

One of the key roles of the lumbo-pelvic region is to transfer load from the lower extremity to the trunk (Snijders, Ribbers, de Bakker, Stoeckart, & Stam, 1998). Whilst all muscles of the trunk can contribute to protection and control of the spine, in cricketers, researchers have focused on abdominal (Hides, Stanton, Freke, Wilson, McMahon, & Richardson, 2008; Hides, Stanton, Wilson, Freke, McMahon, & Sims, 2010) and paraspinal muscles (Hides, Stanton, McMahon, Sims, & Richardson, 2008), as well as the psoas (Hides, Stanton, Freke, et al., 2008) and quadratus lumborum (Hides, Stanton, Freke, et al., 2008; de Visser, Adam, Crozier, & Pearcy, 2007) muscles. Differences have been reported in the symmetry of the quadratus lumborum (Engstrom, Walker, Kippers, & Mehnert, 2007), psoas and oblique abdominal muscles in relation to playing cricket (Hides, Stanton, Freke, et al., 2008). Cricketers with LBP have been shown to have decreased size of the multifidus muscles (Hides, Stanton, McMahon, et al., 2008), be less able to voluntarily draw in the abdominal wall (Hides, Stanton, Freke, et al.,

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2008; Hides et al., 2010) and have increased (or excessive) voluntary contraction of the transversus abdominis (TrA) and internal oblique (IO) muscle when they drew in the abdominal wall when compared with cricketers without LBP (Hides et al., 2010). Motor control training is an approach which has been shown to be effective in reducing pain and disability in both athletic and non-athletic populations (Hides, Stanton, Mendis, Gildea, & Sexton, 2012; Macedo, Maher, Latimer, & McAuley, 2009). Two studies have reported that this approach has been effective in decreasing LBP in elite cricketers (Hides, Stanton, McMahon, et al., 2008; Hides et al., 2010). Changes in muscle parameters which were commensurate with decreases in LBP were increased size of the multifidus muscles, and decreased (excessive) contraction of the TrA and IO muscles when the participants drew in their abdominal walls (Hides, Stanton, McMahon, et al., 2008; Hides et al., 2010).

Whilst the initial focus of motor control training involves voluntary contraction of trunk muscles (Hides, Stanton, Freke, et al., 2008; Hides et al., 2010), it is unknown whether the effects of motor control training can be transferred to other tasks. One study has evaluated the effects of motor control training and general abdominal exercises on automatic recruitment of abdominal muscles (Tsao & Hodges, 2007). Using fine wire electromyography, Tsao and Hodges (2007) demonstrated that training involving voluntary contraction of the TrA muscle resulted in earlier onsets (reversed delay) of this muscle in response to a trunk perturbation task in people with LBP. The pattern of onset demonstrated in people with LBP post training resembled the responses seen in pain free individuals, which was activation of the TrA muscle preceding the oblique abdominal muscles. In contrast, sit-up training resulted in earlier recruitment of all abdominal muscles, and the TrA muscle acted earlier during voluntary movements that induced flexion of the trunk (Tsao & Hodges, 2007). The authors suggested that the changes in abdominal activation following sit-up training may not be optimal to meet the demands of the trunk when perturbed. The findings of this study (Tsao & Hodges, 2007) are important, as it demonstrated that patterns of automatic recruitment can be changed in those with LBP, using a motor control approach, to resemble patterns seen in people without LBP. The finding that general exercises such as sit-ups altered activation of all abdominal muscles to a more general strategy or pattern may not be desirable in people with LBP, as over-activation of superficial trunk muscles has consistently been demonstrated (Geisser et al., 2005; Lariviere, Gagnon, & Loisel, 2000; Silfies, Squillante, Maurer, Westcott, & Karduna, 2005), and is thought to represent “splinting” of the lumbo-sacral spine by the central nervous system (Hodges & Moseley, 2003).

Studies investigating changes in automatic recruitment of abdominal muscles in response to training have not been performed in athletic populations. However, assessment of automatic recruitment in athletes with and without LBP has been investigated using a simulated leg press device (Hides, Belavy, Cassar, Williams, Wilson, & Richardson, 2009; Hides, Wong, Wilson, Belavy, & Richardson, 2007; Hyde, Stanton, & Hides, 2012). This device assesses the automatic response of the abdominal muscles to axial loading during a simulated unilateral weight-bearing task (SUWBT). In both athletic and non-athletic populations, people with LBP have shown different responses to the task. One of the main findings was that people with LBP demonstrated increased contraction of the IO muscle (Hides et al., 2009; Hyde et al., 2012). However, the apparatus has not been used in pre- and post-intervention to determine if changes in recruitment occur in response to motor control training.

The aim of this study was to compare the automatic recruitment patterns of the anterolateral abdominal muscles of elite cricketers with and without LBP, pre and post a motor control training program. The hypothesis was that elite cricketers with LBP would demonstrate altered automatic recruitment of the IO and TrA muscles and that a motor control training program would reduce the difference between groups.

2. Materials and methods

Participant selection was based on attendance at a 13 week national cricket training camp in Brisbane, Australia. The development group was selected by Cricket Australia and the Australian Institute of Sport based on their recent performance at a state-level competition. Twenty-six players attended the camp. This included two wicket keepers, nine batsmen, eight fast or medium paced bowlers, two spin bowlers, and five all-rounders. Of these, three left the training camp early due to injury. Therefore, 26 players were available for assessment prior to commencement of the camp and 23 players were available for assessment at the end of the camp. Recruitment and retention of participants throughout the study is summarized in Fig. 1. All participants gave written informed consent and the rights of the subjects were protected. This study was approved by the relevant ethics committees of the host institutions.

The initial phase of the study consisted of a participant interview and physical examination of each participant by an experienced physiotherapist. Participants were allocated into either a current LBP (LBP) or no LBP (Asymptomatic) group according to the following inclusion and exclusion criteria. Participants who displayed a restriction of movement secondary to LBP and/or reported LBP on manual examination were allocated to the current LBP group. A further inclusion criterion was that LBP was located between the gluteal fold and the T12 vertebra. One participant was excluded from the study due to a pre-existing case of osteitis pubis, which confounded group allocation, as the participant did have painful restriction of movement, but his pain was not located between the gluteal fold and the T12 vertebra. A visual analog scale (VAS) (Scott & Huskisson, 1976), ranging from 0 to 10, was used to establish the intensity of the LBP at the time of testing. The VAS was repeated at the end of the camp to assess for changes in response to intervention. Each participant completed the Habitual Physical Activity Questionnaire (HPAQ) (Baecke, Burema, & Frijters, 1982) at the start of the camp, to determine if groups were comparable at baseline (prior to intervention) with respect to activity levels. This questionnaire has been shown to be valid and reliable (Florindo, Latorre Mdo, Santos, Negrao, Azevedo, & Segurado, 2006; Ono, Hirata, Yamada, Nishiyama, Kurosaka, & Tamura, 2007). Seven

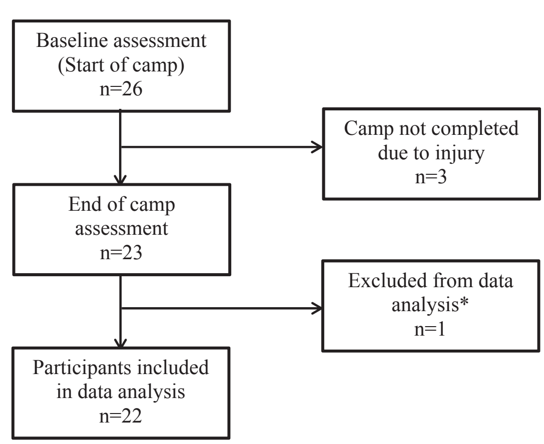

Fig. 1. Flow diagram of study participant recruitment and retention. Abbreviations: n-number of participants. * This participant was excluded from data analysis as they retrospectively reported osteitis pubis, which confounded group allocation.