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Literature review

The biomechanical variables involved in the aetiology of iliotibial band syndrome in distance runners – A systematic review of the literature

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ABSTRACT

The aim of this literature review was to identify the biomechanical variables involved in the aetiology of iliotibial band syndrome (ITBS) in distance runners. An electronic search was conducted using the terms "iliotibial band" and "iliotibial tract".

The results showed that runners with a history of ITBS appear to display decreased rear foot eversion, tibial internal rotation and hip adduction angles at heel strike while having greater maximum internal rotation angles at the knee and decreased total abduction and adduction range of motion at the hip during stance phase. They further appear to experience greater invertor moments at their feet, decreased abduction and flexion velocities at their hips and to reach maximum hip flexion angles earlier than healthy controls. Maximum normalised braking forces seem to be decreased in these athletes. The literature is inconclusive with regards to muscle strength deficits in runners with a history of ITBS. Prospective research suggested that greater internal rotation at the knee joint and increased adduction angles of the hip may play a role in the aetiology of ITBS and that the strain rate in the iliotibial bands of these runners may be increased compared to healthy controls.

A clear biomechanical cause for ITBS could not be devised due to the lack of prospective research.

1. Introduction

Iliotibial band syndrome (ITBS) is an overuse injury associated with pain on the lateral aspect of the knee. Patients have no history of trauma and describe an insidious onset of lateral knee pain during a run. The pain typically appears a few kilometres into a run and increases in intensity as they continue (Aronen, Chronister, Regan, & Hensien, 1993; Fredericson, Guillet, & De Benedictis, 2000; Gunter & Schwellnus, 2004; Renne, 1975). A recent review of the literature found ITBS to be the third most frequent injury amongst distance runners (Hespanhol, Carvalho, Costa, & Lopes, 2011).

1.1. Anatomy

The iliotibial band (ITB) originates from the fascia of the tensor fascia latae and gluteus maximus muscles. This fascia is proximally attached to the iliac crest (Fairclough et al., 2006; Falvey, Clark, Franklyn-Miller, Bryant, Briggs, & McCrory, 2010), anterior superior iliac spine (Birnbaum, Siebert, Pandorf, Schopphoff, Prescher, & Niethard, 2004) and to the capsule of the hip joint (Birnbaum et al., 2004; Falvey et al., 2010; Tichy & Tillmann, 1989). Nearly three quarters of the gluteus maximus tendon blends into the ITB, before attaching at the gluteal tuberosity of the femur (Birnbaum et al., 2004; Falvey et al., 2010; Fetto, Leali, & Moroz, 2002).

The ITB then continues down the lateral aspect of the femur having a broad attachment to the linea aspera and is continuous with the fascia that envelopes the thigh (Birnbaum et al., 2004; Terry, Hughston, & Norwood, 1986). Fairclough et al. (2006) and Falvey et al. (2010) found that the ITB was securely attached to the lateral femoral condyle (LFC) with strong fibrous bands, some of which attached directly onto the lateral femoral epicondyle (LFE).

In the area of the LFC the ITB has attachments to the patella (Birnbaum et al., 2004; Merican & Amis, 2009; Renne, 1975). Towards the distal end of the LFC, it roughly splits into two bands and crosses the lateral knee joint. The one band travels obliquely down and attaches to the infracondylar tubercle of the tibia (Gerdy's tubercle) while the other attaches to the head of the fibula (Birnbaum et al., 2004; Terry et al., 1986).

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1.2. Function

The attachments of the ITB to the pelvis, femur and tibia mean that it passively resists hip adduction and internal rotation as well as anterior translation and internal rotation of the tibia (Ferber, Kendall, & McElroy, 2010; Kwak et al., 2000; Yamamoto, Hsu, Fisk, Van Scyoc, Miura, & Woo, 2006).

The gluteus medius muscle is often seen as the most important stabiliser of the pelvis, preventing excessive hip adduction during gait (Beers, Ryan, Kasubuchi, Fraser, & Taunton, 2008; Fredericson, Cookingham, Chaudhari, Dowdell, Oestreicher, & Sahrmann, 2000). Researchers have shown that these adduction forces can exceed magnitudes of three times body weight during mid stance (Lu, Taylor, O'Connor, & Walker, 1997). Fetto et al. (2002) point out that the amount of energy required to sustain this effort exceeds the metabolic capacity of the gluteus medius. They argue that the robust gluteus maximus muscle, through its attachment into the ITB, tensions the ITB and increases the passive stability around the hip joint (supported by Birnbaum et al., 2004). The tensor fascia latae and vastus lateralis muscles also contribute to the tensioning effect of the ITB (Becker, Baxter, & Woodley, 2010; Birnbaum et al., 2004).

1.3. Aetiology

1.3.1. Friction vs. compression

Early researchers believed that ITBS is caused by inflammation in tissue deep to the ITB due to excessive friction between the ITB and the LFE when the former slides over the latter during repetitive flexion-extension movements e.g. running (Ekman, Pope, Martin, & Curl, 1994; Muhle et al., 1999; Nemeth & Sanders, 1996; Noble, 1979; Orchard, Fricker, Abud, & Mason, 1996; Renne, 1975).

This view has recently been challenged by Fairclough et al. (2006) and Falvey et al. (2010) who argued that the ITB is not a loose structure and it is highly unlikely that the ITB can move from anterior to posterior over the LFE. They found, through MRI, that the ITB compresses against the LFE at about 30 degrees of knee flexion (Fairclough et al., 2006). The researchers concluded from this that ITBS is more likely caused by excessive compression of the richly vascularised and innervated layer of fat between the ITB and LFC (Fairclough et al., 2006, 2007).

The main difference between Fairclough et al. (2006)'s study and the previous investigations (Muhle et al., 1999; Orchard et al., 1996) is that both of the earlier studies were conducted on cadavers. In response to an opinion piece written by Fairclough et al. (2007), Orchard (2007) admitted that *"the specimens we examined in this study* [Orchard et al., 1996] *had already had the ITB dissected away from the remaining (previously attached) fascia latae, so they may not have been representative of the anatomy in vivo"*.

Whether one agrees with the "slipping band" theory of the original research or the "compression" theory of recent studies does not really matter. Both theories rely on an abnormal increase in compression forces between the ITB and the LFC to cause irritation and inflammation in the tissue, since these movements (slipping/compression) appear to be characteristic of an asymptomatic population as well (Fairclough et al., 2006; Muhle et al., 1999; Orchard et al., 1996).

1.4. Contributing factors

The most common factor reported in the literature as contributing to the development of ITBS is a sudden increase in exercise intensity (mileage/hill training/speed work) (Almeida, Williams, Shaffer, & Brodine, 1999; Firer, 1989; Messier et al., 1995; Noble, 1979; Sutker, Barber, Jackson, & Pagliano, 1985; Tenforde, Sayres, McCurdy, Collado, Sainani, & Fredericson, 2011).

Several other possible causes, due to their ability to potentially increase tension in the ITB by altering hip and knee angles, have been identified: downhill running, wearing old shoes, always running on the same side of a cambered road, leg length discrepancies, excessive pronation of the foot, a tight ITB and weakness of the gluteus medius muscles (Barber & Sutker, 1992; Firer, 1989; Fredericson, Cookingham, et al., 2000; Krivickas, 1997; Orchard et al., 1996; Sutker et al., 1985).

Messier et al. (1995) proposed that, in athletes who possess a certain combination of intrinsic factors, the musculoskeletal system becomes overwhelmed if the mileage is increased beyond a threshold level and manifests itself as injury. Several researchers have tried to build on this hypothesis by investigating the biomechanics of runners with ITBS during running (Ferber, Noehren, Hamill, & Davis, 2010; Grau, Krauss, Maiwald, Axmann, Horstmann, & Best, 2011; Grau, Krauss, Maiwald, Best, & Horstmann, 2008; Grau, Maiwald, Krauss, Axmann, & Horstmann, 2008; Hamill, Miller, Noehren, & Davis, 2008; Messier et al., 1995; Messier & Pittala, 1988; Miller, Lowry, Meardon, & Gillette, 2007; Miller, Meardon, Derrick, & Gillette, 2008; Noehren, Davis, & Hamill, 2007; Orchard et al., 1996). These researchers, though, have reported varying and sometimes contradicting results and their work is the main focus of this literature review.

The aim of this literature review is to establish whether distance runners who suffer from or develop ITBS demonstrate lower limb biomechanics that are different from those of runners who do not suffer from or develop ITBS. Identification of such predisposing biomechanics could lead to early intervention to better treat and prevent injuries.

2. Methods

2.1. Literature search

An electronic search was conducted, using the terms "iliotibial band" and "iliotibial tract", of the following databases and websites from inception to July 2011: PEDro, Cochrane Library, National Institute for Health and Clinical Excellence, NIHR Health Technology Assessment programme, Allied and Complementary Medicine, British Nursing Index, CINAHL Plus with full text, E-Journals, Highwire Medical Journals, PsycARTICLES, PsycINFO, SPORTDiscuss, Biomed central, EMBASE, Expanded Academic ASAP, ProQuest Medical Library, Pubmed Central, PubMed, SAGE Premier 2011, Science Citation Index Expanded, Science direct, Web of Science, Wiley-Blackwell Journals, Ingenta Connect, Google Scholar, www.clinicaltrials.gov, World Health Organisation: International Clinical Trials Registry Platform Search Portal, Health Management Information Consortium, Library of Archives of Canada, University of Helsinki, ProQuest Dissertation and Thesis website, Australian Digital Theses, Cybertesis.net, National Library of Australia (TROVE), Ethos UK, DUT Library.

Relevant articles' reference lists were hand searched for additional relevant titles.

2.2. Study selection

The following inclusion and exclusion criteria were used during study selection:

Inclusion criteria:

- Literature: Published and unpublished research.
- Study design: Prospective or retrospective randomised controlled trials, non-randomised controlled trials and case control studies were included.