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Original article

Comparisons of hip strength and countermovement jump height in elite tennis players with and without acute history of groin injuries

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ABSTRACT

Background: Despite the high groin-injury (GI) prevalence in tennis, no studies have assessed the extent to which intrinsic groin injury risk factors, such as hip muscle strength, have recovered in elite tennis players with a history of previous GI.
Objective: To investigate whether elite tennis players with a history of GI show differences in hip strength and jump height between injured and uninjured limbs and compared with dominant limb in tennis players without history of acute groin-injuries (NGI).
Design: Cohort study.
Participants: Sixty-one tennis players completed this study: 17 in the GI group and 44 in the NGI. Isometric adductor and abductor hip strength were assessed with a handheld dynamometer, and unilateral counter-movement jump tests were performed on a contact mat connected to an Ergo tester. Paired t-tests were conducted to identify differences between injured and non-injured limbs in the GI group, and independent measures t-tests were conducted to compare between GI and NGI groups.
Results: Isometric adductor strength and adductor/abductor strength ratios were lower in the injured limb (16.4% and 20.1%, respectively) compared with uninjured side within the GI group, and lower than the dominant side in the NGI group. No significant differences were found for unilateral jump heights between sides in the GI, nor isometric abductor strength, when comparing GI to NGI groups.
Conclusions: Isometric adductor weakness and adductor/abductor strength ratio deficits suggest that adductor muscle strength is not fully recovered in these athletes, potentially increasing their risk of a repeat groin injury.

1. Introduction

Groin injuries account for between 2 and 13% of all sports injuries (Morelli and Smith, 2001; Waldén et al., 2015). Specifically, they are one of the most frequent type of lower limb injury in elite junior tennis players (Hutchinson et al., 1995; Pluim et al., 2016) with an incidence of 0.8 per 1000 athletic exposures and a prevalence of 1.3 hip injuries per 100 players (Hutchinson et al., 1995). Furthermore, Sell et al. (2013) reported 2.84 groin injuries per 1000 playing hours in tennis matches, accounting for 25% of all acute injuries in elite junior tennis players (Pluim et al., 2016).

Multiple pathologies (e.g., hernia, pubic bone or edema/avulsion fractures, adductor strains, adductor tendinopathies, external oblique or rectus abdominis tear, nerve entrapment, as well as hip joint pathology) may cause similar symptoms and can refer pain to the groin region (Hölmich, 2007; Werner et al., 2009; Tyler et al., 2010). However, the literature indicates that adductor strains are one of the most common injuries in tennis players (Lovell, 1995; Pluim et al., 2016). These injuries usually result from sudden changes in direction, particularly when attempting to stop lateral movement by sliding or posting the lead foot (Kibler and Safran, 2005).

Previous studies conducted in field-based sports (i.e. soccer, ice-hockey, rugby or Australian football) have identified several factors related to an increased risk of groin injuries. These include older age (Emery and Meeuwisse, 2001; Arnason et al., 2004; O'Connor, 2004), level of competition or experience (Tyler et al., 2001;

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Hölmich et al., 2010), decreased range of hip abduction and rotation (Arnason et al., 2004; Ibrahim et al., 2007), isometric adductor muscle weakness or high abductor/adductor strength ratio and poor performance in vertical jump tests (Tyler et al., 2001; Arnason et al., 2004; O'Connor, 2004; Engebretsen et al., 2010; Ryan et al., 2014). However, a number of studies have reported that having a previous groin injury is the most prominent risk factor identified for groin injury (Arnason et al., 2004; Hägglund et al., 2006; Gabbe et al., 2010; Engebretsen et al., 2010; Ryan et al., 2014), being associated with a 2–3-fold increase in risk of an identical injury in the same limb (Arnason et al., 2004; Hägglund et al., 2006; Ryan et al., 2014). Many recurrent injuries have been attributed to inadequate rehabilitation or premature return to play after the initial injury, thus are due to residual deficits in previously injured muscles (Hägglund et al., 2006). For example, soccer players with previous hamstring injuries showed lower knee flexion strength than those with no history of hamstring injury (Croisier et al., 2002). Similarly, Engebretsen et al. (2010) reported that the combination of adductor weakness and previous acute groin injuries could predict an increased risk of new groin injuries in soccer players.

Despite the high groin injury prevalence in tennis players with a history of previous groin injury, to the best of our knowledge, no studies have assessed the extent to which intrinsic groin injury risk factors, such as hip muscle strength, have recovered in elite tennis players with a history of previous groin injury. A more thorough knowledge of each player's physical status could help practitioners and physiotherapists improve injury management. Hence, the aim of this study was to compare differences in strength factors related to groin injuries in tennis players with and without a history of acute groin injury. Specifically, isometric adductor and abductor muscle strength, adductor/abductor strength ratios and unilateral counter-movement jump (CMJ) heights were measured. Secondly, the relationship between previous injury and other intrinsic factors such as age, weight, height, body mass index, years of tennis practice and hours of practice per day was investigated, comparing players with a history of acute groin injuries to those with no history of groin injuries.

2. Methods

2.1. Participants

Sixty-one professional right-handed male tennis players volunteered for this study. Based on the Consensus statement on epidemiological studies of medical conditions in tennis defined by Pluim et al. (2009), the players were divided in two groups: (1) those with a history of acute groin injury (GI group) in the past 2–12 months (mean time from injury to testing 6.9 ± 2.0 months; no injury within the past 2 months); or (2) players who have no history of acute groin injury (NGI group). Inclusion criteria were belonging to the Association of Tennis Professionals (ATP) or International Tennis Federation (ITF) World Tour, being competitively active at the time of the study, not currently suffering any hip and groin injury and not taking any type of medication related to treatment of pain or musculoskeletal injuries at the time of the study.

Written informed consent was obtained from each player prior to testing. The study was approved by the University Office for Research Ethics Committee, and conformed to the recommendations of the Declaration of Helsinki.

2.2. Data collection

Players were tested during the 2013 preseason, from October through December. All assessments were conducted by the same two researchers: examiner 1 conducted all tests (>15 years' experience) and the examiner 2 (5 years' experience) ensured consistent participant positioning throughout.

Tennis players visited the testing facility on two separate occasions and at the same time of day to avoid diurnal variability. A week before testing, tennis players were familiarized with the tests, to reduce the influence of the learning effect. At the beginning of each testing session, participants performed 5 min of warm-up (jogging) and standardized static stretching exercises, according to Cejudo et al. (2015). Specifically, the participants performed 2 repetitions of 7 different unassisted static stretching exercises, holding the stretch position for 30 s. On the first day, before the warm-up and stretching, questionnaires were completed regarding anthropometrical parameters, sport and medical history, then participants' isometric hip adductor and abductor strength were tested. On the second day, unilateral countermovement jumps were measured.

2.3. Measurements

2.3.1. Questionnaire

Each participant's height and weight were documented, as well as age, upper and lower limb dominant side, years of tennis practice, training volume (i.e., hours per week, day), and report of previous injuries. For our study, acute groin injury was defined according to Pluim et al. (2009) and Fuller el al. (2006). Specifically, an acute groin injury was referred to as a condition resulting from a specific, identifiable event, or when there is a sudden onset of pain or disability, leading to an absence of a training session or match. The dominant limb was determined according to the definition of Thorborg et al. (2011), who defined preferred leg for kicking a ball as the dominant limb.

2.3.2. Hip strength test

Isometric hip adduction (ADD) and abduction (ABD) strength for the dominant and non-dominant side were tested with a portable handheld dynamometer (Nicholas Manual Muscle Tester, Lafayette Indiana Instruments). The handheld dynamometer was calibrated before testing. In order to compare our results with previous studies, all test procedures were standardized according to protocols established by Thorborg et al. (2010). In addition, a test-retest pilot study was performed on 10 young athletes in order to assess the reliability of this protocol. Specifically, good absolute (3.7% < typical error < 6.2%) and relative (0.83 < Intraclass correlation coefficient – $ICC_{3,1}$ < 0.96) intersession reliability was found. Isometric hip abduction and adduction strength was tested in supine with the hip in a neutral position. While being tested, participants stabilized by holding on to the sides of the table with both hands, with the opposite lower limb in flexion (Fig. 1a and b, respectively). Examiner 1 applied resistance via a dynamometer placed 5 cm proximal to the proximal edge of the lateral (for abductor) or medial malleolus (for adductor). Maximum voluntary contractions were repeated 3 times, held for 5 s each (Thorborg et al., 2010), with 30 s rest in between.

2.3.3. Countermovement jump testing

Unilateral (both limbs) CMJ tests (Fig. 2) were used to indirectly measure the power of the lower limbs (Arnason et al., 2004). Hands were held at the hips as described by Lian et al. (1996). From a standing position with straight knees, the player squatted down to at least 90° before jumping as high as possible. They were instructed to jump and land in exactly the same place, with the body in an erect position during the jump until landing.