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Correlation between quadriceps and hamstrings inter-limb strength asymmetry with change of direction and sprint in U21 elite soccer-players

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A R T I C L E I N F O

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A B S T R A C T

The aim of this study was to investigate the relationship between in quadriceps and hamstrings inter-limb strength asymmetry and change of direction, sprinting and jumping abilities in U21 elite soccer players. Twenty-seven soccer players volunteered for this study. Isokinetic quadriceps and hamstrings peak torque was measured at high and low angular velocities, both in concentric and eccentric modalities. Performance in agility T-test, 20 + 20 m shuttle-test, 10 m and 30 m sprint, squat jump (SJ) and counter-movement jump (CMJ), were measured. Overall, time on agility T-test and 20 + 20 m shuttle-test was moderately and positively correlated with the quadriceps and hamstrings inter-limb eccentric peak torque asymmetry, both at high and low angular velocities. In addition, time on 10 m and 30 m sprints was moderately and positively correlated with the hamstrings inter-limb high-velocity concentric peak torque asymmetry. SJ and CMJ showed trivial to small correlations with hamstrings and quadriceps inter-limb peak torque asymmetry. The present results provide further information insight the role of lower-limb muscle strength balance in COD, sprinting and jumping performance.

1. Introduction

With the increase in physiological demands shown in soccer matches in the last decade, the importance of players' physical abilities has also increased (Bush, Barnes, Archer, Hogg, & Bradley, 2015). It was recently shown that change of direction (COD) and sprinting affect the players' external and internal loads (Coratella, Beato, & Schena, 2016). In addition, players are also required to jump to contest the ball from the opponent player (e.g., from a cross or corner). COD, sprinting and jumping require lower-limb muscles to exert maximal strength to accelerate and decelerate body mass, both in horizontal and in vertical directions (Bobbert, Gerritsen, Litjens, & Van Soest, 1996; Morin et al., 2015). Hence, the interest in the relationship between lower-limb muscle strength and such abilities has arisen over time (Brooks, Clark, & Dawes, 2013; Comfort, Stewart, Bloom, & Clarkson, 2014; de Hoyo et al., 2015; Kellis & Katis, 2007; Newman, Tarpenning, & Marino, 2004; Ostenberg, Roos, Ekdahl, & Roos, 1998; Wisløff, Castagna, Helgerud, Jones, & Hoff, 2004).

Among the several lower-limb muscle-groups, quadriceps and hamstrings are widely involved in COD, sprinting and jumping (Silva, Nassis, & Rebelo, 2015). Therefore, the studies that have investigated the correlation between lower-limb muscle strength and performance in COD, sprinting and jumping have mainly focused on quadriceps and hamstrings (Morin et al., 2015; Newman et al.,

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2004; Wisløff et al., 2004). Particularly, since during COD sprinting and jumping they act in both concentric and eccentric modalities, the use of an isokinetic dynamometer allows to separately measure the concentric or eccentric maximal strength of both quadriceps and hamstrings (Brooks et al., 2013; Chaouachi et al., 2012; Coratella, Bellin, Beato, & Schena, 2015; Coratella, Bellini, & Schena, 2016; Ostenberg et al., 1998). Specifically, peak torque is mostly used as a valid and reliable parameter to measure maximal strength (Brooks et al., 2013; Coratella & Bertinato, 2015; Impellizzeri, Rampinini, Maffiuletti, & Marcora, 2007; Ostenberg et al., 1998). Screening the quadriceps and hamstrings peak torque allows the evaluation of inter-limb or anterior-posterior asymmetry in strength, which is used to monitor muscle strength asymmetries that are strongly correlated with high risk for hamstrings strain injury (Fousekis, Tsepis, Poulmedis, Athanasopoulos, & Vagenas, 2011). Indeed, several studies have investigated the hamstrings-to-quadriceps peak torque ratio (Coratella, Bellin, et al., 2015; Coratella, Bellini, et al., 2016; Delextrat, Gregory, & Cohen, 2010) or the inter-limb asymmetry in hamstrings peak torque (Fousekis et al., 2011) and their relationship with injury risk in soccer players.

In professional soccer players, inter-limb asymmetry in quadriceps and hamstrings maximal strength indicated a reduced muscle function and an increased risk of injury (Hägglund, Waldén, & Ekstrand, 2013). Particularly, it was shown that an hamstrings inter-limb eccentric strength asymmetry is a predictor of hamstrings strains (Fousekis et al., 2011). In addition, strength dominance was shown to account for a better drive kick performance with the stronger limb (McLean & Tumilty, 1993). Thus, inter-limb strength symmetry seems desirable for improving performance in soccer-related abilities (Rouissi et al., 2016). Notwithstanding, little is known about the relationship between quadriceps and hamstrings inter-limb strength asymmetry and COD, sprinting and jumping abilities in soccer players. Quadriceps inter-limb strength asymmetry accounted for a decrease in COD performance in young soccer players when required to side-step with the weaker vs stronger limb (Rouissi et al., 2016). In contrast, quadriceps inter-limb isokinetic peak torque asymmetry showed no correlation with the difference in single-limb jump height performed with the stronger or weaker lower-limb in physically active men (Kobayashi et al., 2013). Similarly, a computer-simulation study found negligible differences between inter-limb symmetry vs asymmetry bilateral jump height models, speculating that the stronger lower-limb could have compensated for the muscle deficit of the weaker limb in both squat jump (SJ) (Yoshioka, Nagano, Hay, & Fukashiro, 2011) and counter-movement jump (CMJ) (Yoshioka, Nagano, Hay, & Fukashiro, 2010).

Investigating the relationship between quadriceps and hamstrings inter-limb maximal isokinetic strength asymmetry and COD, sprinting and jumping performance could help to clarify the role of muscle strength imbalance and its impact on performance. Therefore, the aim of the current study was to investigate the correlation between the quadriceps and hamstrings inter-limb isokinetic concentric and eccentric peak torque asymmetry and COD, sprinting and jumping performance in U21 elite soccer players.

2. Methods

2.1. Experimental design

The present investigation was designed as a cross-sectional study. The sample size a priori was calculated using a sample size calculator (G-Power 2.0, Brunsbuttel, Germany). Assuming the effect size = 0.5 (moderate), the α-error = 0.05 and the power = 0.8, the sample size resulted in 21 participants. Due to the higher number of participants recruited, an a-posteriori power analysis resulted as 1-β = 0.89.

2.2. Procedures

The present investigation was assessed in pre-season. The participants were involved in two testing sessions per week for two weeks, for a total of four testing sessions. In the first week, the participants were accustomed to the isokinetic testing procedures (first session) and to the COD, sprinting and jumping procedures (second session). In the second week, the participants were tested according to the same procedures of the first week. The isokinetic and the COD, sprint and jump testing-order were randomized over the two testing-sessions, i.e.: the participants performed either isokinetic or COD, sprint and jump measurements within the same session (Chaouachi et al., 2012; Fousekis, Tsepis, & Vagenas, 2010). Particularly, four different isokinetic testing-orders including hamstrings or quadriceps and right or left lower-limb were randomized among the participants (Fousekis et al., 2010). Similarly, four different testing-orders including COD, sprinting and jumping measurements were randomized among the participants. The randomization of the COD, sprinting and jumping measurements was done to avoid that the same testing-order may have resulted in a possible fatigue within the same task. Each testing-session was separated by at least two days.

Inter-limb asymmetry in quadriceps and hamstrings isokinetic peak torque was selected as the independent parameter. For a comprehensive evaluation, the knee-extension and knee flexion peak torque of both quadriceps and hamstrings was measured at both low and high knee angular velocities, both in concentric and in eccentric modalities. Therefore, a total of eight different testing modalities were carried out. The testing order consisted of first concentric, from low to high angular velocity and then eccentric, from low to high angular velocity, as previously used (Rahnama, Reilly, Lees, & Graham-Smith, 2003).

The dependent parameters were selected from the most used in literature that evaluate the physical abilities in soccer (Silva et al., 2015). Therefore, COD was evaluated using the 20 m + 20 m shuttle-test and agility T-test; sprinting ability was assessed by the 10 m and 30 m sprint test and jumping ability was evaluated with SJ and CMJ. Although soccer players are not typically required to perform specific SJ or CMJ actions during a match, it is acknowledged that these types of jumps are largely used to evaluate the improvement in jumping ability in soccer players (Silva et al., 2015). In addition, due to the inter-limb symmetrical nature of both SJ and CMJ, it was decided to evaluate if an inter-limb asymmetry could affect the jumping ability in both jumps (Yoshioka et al., 2010). Finally, the procedures of both SJ and CMJ are simple and clearly related to lower-limb maximal strength (Yoshioka et al., 2010).