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Original research

Postural stability decreases in elite young soccer players after a competitive soccer match

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ABSTRACT

Objective: To investigate the effects of an official soccer match on postural stability in youth elite soccer players.
Design: Single-group pre-post design.
Setting: Competitive soccer match.
Participants: Twenty elite U-19 male soccer players (mean age: 17.7 ± 1.0 years) of which 11 completed the full experimental set-up.
Main outcome measures: Postural stability evaluated by unilateral stance tests for dominant and non-dominant lower limbs on a force plate under two visual conditions: eyes opened (EO) and eyes closed (EC).
Results: After the match, the centre of gravity (CoG) sway velocity with EO increased on the dominant and non-dominant limbs (median [interquartile range], 0.90°/s [0.60–1.10] vs. 1.10°/s [0.60–1.60]; and 0.70°/s [0.50–0.90] vs 1.00°/s [0.70–1.30]; respectively; $p < 0.05$). The CoG sway velocity with eyes closed did not change pre- to post-match.
Conclusions: The soccer match decreased the postural stability only when the assessment was conducted with eyes open.

1. Introduction

Soccer is a high demand sporting activity with a high prevalence of lower limb injuries, namely knee and ankle sprains (Rahnama, Reilly, & Lees, 2002; Walden, Hagglund, & Ekstrand, 2005). It has been reported that the majority of those injuries are sustained in the last third of each half during matches (Rahnama et al., 2002). The higher number of injuries sustained during the last third of practice sessions or matches has been associated with changes in lower limb neuromuscular control and joint dynamic stability due to fatigue (Hiemstra, Lo, & Fowler, 2001).

In soccer, the physiological mechanisms responsible for fatigue appear to change during different periods of a match, and may be attributed to metabolic or neurologic factors controlled peripherally and centrally by the neuromuscular system (Mohr, Krustrup, & Bangsbo, 2005). Nevertheless, muscle fatigue modifies the peripheral proprioceptive system by increasing the threshold for muscle–spindle discharge and consequently changing alpha/gamma co-activation (Ribeiro, Santos, Gonçalves, & Oliveira, 2008). Therefore, neuromuscular control, as represented through deficits in postural control, might decrease due to fatigue (Gribble & Hertel, 2004).

Muscle force of the muscles of the ankle, knee, and hip decreases due to fatigue (Gribble & Hertel, 2004). Additionally, previous studies with athletes indicated that neuromuscular control, proprioception, and functional stability are impaired after fatiguing exercise which might increase the injury risk of muscular and ligamentous structures, mainly in more dynamic movements (Greig & Walker-Johnson, 2007; Ribeiro et al., 2008). Indeed, postural sway was found to predict the susceptibility to ankle sprain injury, with those with worse postural sway experiencing a higher number of ankle sprains during a competitive season (McGuine, Greene, Best, & Leverson, 2000). In soccer, high-level players experience fatigue in the last 15 min of each half

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(Krustrup, Mohr, & Bangsbo, 2005; Mohr et al., 2005) and players may also experience deficits in postural balance during the last 15 min of each half of a match, as soccer-specific fatigue have been suggested to influence functional stability of players in match play (Greig & Walker-Johnson, 2007). Therefore, reduced postural stability might explain why injuries tend to occur towards the final stages of each half of the match.

However, no study so far investigated the effects of a competitive official match on the balance ability of soccer players. Several studies investigated the impact of fatigue in functional stability and proprioception in the athletic setting, but most studies used laboratory protocols or simulated soccer matches, which could not accurately reproduce the real demands of competitive match play (Greig & Walker-Johnson, 2007; Ribeiro et al., 2008). Indeed, field studies could have the advantage of reproducing more specifically the changes in neuromuscular control and postural stability observed in sport settings. Hence, the purpose of this study was to investigate the effects of an official soccer match on postural stability in youth elite soccer players.

2. Methods

2.1. Participants

Twenty elite U-19 male soccer players with a mean age of 17.7 ± 1.0 years (range: 16–19 yrs), an average height of 173 ± 4 cm (range: 167–179 cm), and an average body mass of 67.4 ± 3.8 kg (range: 61.0–73.8 kg), participated in the study. During the season, the players were training 4 times per week, 1.5 h per session, plus 1 match per week. The study was conducted in the mid-season. A physician interviewed and examined the players to guarantee that all participants presented normal knee and ankle range of motion, no history of previous knee or ankle surgery, and were not recovering from lower limb injury. Goalkeepers were excluded from the study, as well as those players not completing the 90-min game. Limb dominance was assessed by asking which limb the players used to kick a ball. The study procedures were in accordance with the ethical standards on human experimentation. Written informed consent was obtained from players and parents/guardians. The local Ethics Committee approved ethical consent.

2.2. Soccer match

In order to closely reproduce the fatigue induced by soccer play, the subjects were evaluated in an official soccer match (semi-final of the U-19 league). Prior to the match, the players refrained from strenuous exercise for 48 h, and arrived at the stadium 2.5 h before the match. The players performed all the usual procedures before the game, including the warm-up, and were allowed to drink water *ad libitum*. The soccer match took place in the afternoon, at 5 p.m. The ambient temperature and humidity were 17 °C and 78%, respectively.

To ensure that the match was sufficiently intense, general fatigue was assessed at the end of the match using visual analogue scale (VAS) questionnaires. VAS has shown good reproducibility and sensitivity for subjective ratings of physical activity (Grant et al., 1999). The VAS consisted of a horizontal line ranging from 0 to 100, but the players were unaware of the numbers. The players who completed the soccer match (90 min duration) presented general fatigue scores of 50.5 ± 17.8 units.

2.3. Postural stability assessment

The force plate was placed 25-m away from the soccer pitch, in an indoor sports hall. All tests were performed during the last 90 min before the warm-up and within 45 min after cessation of match play. Postural stability was evaluated by a one leg stance test over a firm surface in a *Balance Master System*® force plate (Neurocom International, Version 8.2, Clackamas, OR, USA). These assessments have been used and validated by extensive scientific and clinical research (Subasi, Gelecek, & Aksakoglu, 2008; Zouita Ben Moussa, Zouita, Dziri, & Ben Salah, 2009). Moderate to excellent intraclass correlation coefficients were reported for standing balance tests, suggesting that the single-limb standing balance tests are appropriate for distinguishing among group performances (Birmingham, 2000), although the *Balance Master System*® showed fair to good reliability for postural parameters in 9–10 year olds (Geldhof et al., 2006). Additionally, it has been suggested that minimum difference of 10–30% would be necessary to depict a measurable change in a postural sway in order to confidently state that a true change had occurred (Birmingham, 2000; Rose & McKillop, 1998).

The unilateral stance (US) assessment quantifies postural sway velocity by measuring the ability to control the centre of gravity (CoG) over the base of support during various visual conditions. The US test consisted of four conditions, each consisting of three 10-s trials, with 10-s rest periods between sets. For each subject, the test was completed in approximately 4 min. The test was conducted in the following order: eyes opened (EO) left, eyes closed (EC) left, EO right, EC right. In each trial, the subject put the weight on the left or right foot, with eyes opened or eyes closed, maintaining a slight knee flexion position (10–30°). Subjects were instructed to maintain the head, arms and hips in a steady position, but were allowed to slightly move the arms to assist postural control. After being informed by the examiner, the subject lifted the foot/leg up, and stood as steadily as possible for 10 s. During the test, the subjects were asked to hold still, i.e. to minimize the movement of the CoG. Foot movements were permitted, although contact between the raised limb and the stance limb was not (McGuine et al., 2000). If the subject momentarily (lightly) touched the force plate with their raised foot before the 10-s trial was complete, data collection continued, and the trial remained valid. However, if the subjects lost their balance completely (i.e. fell off the force platform or had left their foot down on the force plate for more than 1 s), the trial was stopped and discarded and the subject repeated the trial (McGuine et al., 2000). The CoG sway velocity, defined as the ratio of the distance travelled by the CoG (expressed in degrees) to the time of the trial (10 s), was sampled at a frequency of 20 Hz, and indicated how well the subject accomplished this task(NeuroCom®, 2004). Small sway scores reflect greater stability (thus better postural stability), whereas large scores indicate less stability. Subjects were removed from further analysis if they did not complete the full experimental set-up.

2.4. Data analysis

All data were analysed using SPSS 19 (SPSS, Inc., Chicago, Illinois) software. US data (EC and EO) was used to calculate mean EC/EO ratio. The EC/EO ratio has been used in the literature to reflect the influence of vision (Lê & Kapoula, 2008). Variables were tested for normal distribution with the Shapiro–Wilk test. As the variables were not normally distributed, pre- and post-match differences in postural stability measurements were calculated using the Wilcoxon non-parametric test. Statistical significance was set at $p < 0.05$ and data are presented as median and interquartile range (IQR).