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Original Research

Relationship between static and dynamic balance abilities in Italian professional and youth league soccer players

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ABSTRACT

Objectives: To assess the existence of correlations between static and dynamic balance abilities in young and professional elite soccer players.
Design: Cross-sectional.
Participants: Fifty-one elite players who regularly compete at national level divided into two groups: Professional (age 18–34, $n = 20$) and Under 15–17 (age 14–16, $n = 31$).
Main outcome measures: Dynamic balance was assessed for the case of a single-leg landing task by means of vertical time to stabilization (TTS) and postural sway calculated on the basis of center-of-pressure (COP) trajectories (sway area, COP displacements in antero-posterior and medio-lateral direction, COP path length). The same parameters were also measured for a 20 s one-legged stance to assess static balance abilities.
Results: No significant correlations were found between static and dynamic balance parameters except for TTS and COP displacements in the antero-posterior direction ($r = 0.29$, $p = 0.003$). Professional players are characterized by lower TTS in comparison with youth leagues players (0.767 vs. 1.188 s for the dominant limb, $p < 0.001$) and exhibit reduced sway area (of 34–40%, $p < 0.05$) for both conditions tested.
Conclusion: The assessment of balance in soccer players should be performed with both dynamic and static tests, considering that the postural control performances in the two cases are not related.

1. Introduction

Although often not specifically indicated as one of the primary features of top-level soccer players, balance represents a crucial aspect that contributes to greatly enhancing their performance. In fact, in most match situations, the lower limbs assume distinct roles in which one of them is required to provide necessary body support and stability when the other one kicks, dribbles, passes etc (Teixeira, de Oliveira, Romano, & Correa, 2011). This task can be accomplished if good postural control (especially in unipedal conditions) exists, and if balance can be easily and quickly recovered after sprints, jumps and cutting maneuvers, which are typical of this discipline and repeated many times during both training and competitions.

In recent times, a number of studies have investigated balance abilities of soccer players with the aim of comparing their performance with those of athletes of other sports (Matsuda, Demura, & Demura, 2010; Matsuda, Demura, & Uchiyama, 2008), assessing the effects of generic or specific training (Gioftsidou, Malliou, Pafis, Beneka, Godolias & Manganaris, 2006) and understanding how fatigue (Brito, Fontes, Ribeiro, Raopso, Krustrup & Rebelo, 2012; Pau, Ibba & Attene, 2014), player maturation and playing position (Paillard & Noé, 2006; Paillard, Noé, Riviére, Marion, Montoya & Dupui, 2006; Pau, Leban, Ibba & Scorcu, 2014) can affect postural control effectiveness. In most cases, balance was assessed through postural sway analysis on the basis of center-of-pressure (COP) trajectories acquired with devices such as force and pressure platforms. In other cases, simpler non-instrumental field tests were

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employed, such as the measurement of time for which an individual is able to keep a unipedal stance without the other foot touching the ground (Riemann, Myers, & Lephart, 2002).

It is noteworthy that most studies on balance of soccer players analyze only static standing, whilst it would be desirable to acquire information about conditions more similar to those encountered in actual matches or training sessions. This means that measures obtained under dynamic conditions are needed rather than (or as well as) those related to simple static stance.

Although instrumental dynamic balance testing is a bit more complicated and challenging task in terms of experimental design and data processing, a number of methods have been developed and tested in the last twenty years, so that robust techniques of analysis are currently available. Among them, the most commonly employed appear to be:

1. Computerized systems equipped with movable force platforms (e.g. Biodex® balance system) that supply a dynamic stability index calculated on the basis of a set of routines that challenge the postural control system through displacements and rotations of the base of support (Cachupe, Shifflett, Kahanov & Wugalther, 2001);
2. Fixed force platforms. In this case the processing of vertical, medio-lateral (ML) and antero-posterior (AP) ground reaction forces (GRF) collected for transitions from dynamic to static conditions (the typical case is represented by landing after a jump) allows the calculation of several dynamic balance indexes explained in detail later.

This latter technique is the most widespread as being more representative of actual sports conditions: in fact, athletes (and in particular soccer players) are not usually required to perform on unstable surfaces (Wikstrom, Tillman, Smith, & Borsa, 2005).

In the specific case of soccer players, the instrumental analysis of postural sway for static standings has been proven reliable in discriminating high-from low-level players (Paillard et al., 2006) young from mature (Pau et al., 2014a, 2014b) and some authors also speculate that a simple static analysis might to some extent be helpful in establishing the risk of lower limb injuries (Beynnon, Murphy, & Alosa, 2002; Trojian & McKeag, 2006). Nevertheless, dynamic balance has been scantily investigated in soccer, especially as regards elite players and, more importantly, it is currently unknown whether a correlation between static and dynamic balance abilities exists.

Thus, the present study intends to analyze such aspects by testing a sample of elite professional and youth league players to answer the following questions: 1) are dynamic balance abilities related to player skill as occurs in the case of static balance?, and 2) are static and dynamic balance abilities correlated?

2. Methods

2.1. Participants

In the period September–December 2013, 51 professional and youth league players affiliated with the Cagliari Calcio club (Cagliari, Italy) were recruited for the study on a voluntary basis. The main criteria for inclusion were participation in the highest ranked national tournament for each specific age range and the absence of lower limb injuries in the six weeks prior to the test. The participants belong to three teams, namely the major Italian League (a.k.a. *Serie A*, $n = 20$) Under 17 and Under 15 ($n = 31$). The latter two teams compete in the respective national tournaments for their age range. Their main anthropometric features are reported in Table 1. The dominant limb of each participant was defined by asking him his preference when kicking the ball. All the players regularly train either for five (professional) or four (Under 17 and Under 15) 90-min sessions per week, plus a tournament match (all of them) during the competitive season, approximately from September–October to June.

The study was carried out in compliance with the ethical principles for research involving human subjects expressed in the Declaration of Helsinki, and was approved by the Departmental Review Board. Written informed consent was obtained from all participants (and their parents if under 18 years of age) after a detailed explanation of the purposes of the study and a description of the experimental methodology.

2.2. Data acquisition and post-processing

Both static and dynamic balance tests were performed using a pressure platform (FDM-S, Zebris Medical GmbH, Germany, 120 Hz acquisition frequency) composed of 2560 capacitive sensing elements arranged in a 64 × 40 matrix, and connected via USB interface to a Personal Computer.

Static balance was assessed by means of postural sway analysis performed under unipedal stance conditions. The players were asked to stand barefoot on the plate, as still as possible for 20 s, with the supporting foot placed on the platform so as to have the axis approximately parallel to the minor axis of the instrument surface and the other leg raised in such a way as to have the suspended foot approximately at the supporting limb malleolus height while the arms were held in the lumbar region.

The COP time series were low-pass filtered (10 Hz cutoff; 4th-order Butterworth; bidirectional) and then post-processed with a custom-developed Matlab® routine to calculate the following sway parameters:

- sway area (SA, 95% confidence ellipse),
- COP path length (COP PL, the overall distance travelled by the COP during the trial)
- COP maximum displacement (MDISP., i.e. the difference between the maximum and minimum value of the selected coordinate recorded during the trial) in the medio-lateral (ML) and antero-posterior (AP) directions.

Dynamic balance was assessed by means of postural sway analysis (similar to what was described above) and vertical TTS (vTTS) determination, the latter obtained through the procedure described in previous studies (Colby, Hintermeister, Torry, & Steadman, 1999; Flanagan, Ebben, & Jensen, 2008; Wikstrom, Powers, & Tillman, 2004). To this end, players were required to jump with both legs from a starting line 90 cm from the center of the platform and land on a single limb with the aim of stabilizing the body as quickly as possible with the help of their arms (Fig. 1).

Subjects were instructed to jump to a submaximal self-selected height and, after landing, to stand as still as possible until they received a verbal signal marking the end of the trial. In this case,

Table 1
Anthropometric features of the participants. Values are expressed as means ± SD.

	Professional	Youth leagues
Players (#)	20	31
Age (years)	27.5 ± 3.8	15.6 ± 0.9
Height (cm)	181.8 ± 6.2	172.7 ± 6.2
Body Mass (kg)	75.6 ± 6.1	61.3 ± 7.9
Body Mass Index (kg m^{-2})	22.9 ± 1.1	20.5 ± 1.9
Dominant limb	16 R, 4 L	24 R, 7 L
R = right, L = left		