Original Article

Balance training programs for soccer injuries prevention

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ABSTRACT

Gioftsidou A, Malliou P, Pafis G, Beneka A, Tsapralis K, Sofokleous P, Kouli O, Roka S, Godolias G. Balance training programs for soccer injuries prevention. *J. Hum. Sport Exerc.* Vol. 7, No. 3, pp. 639-647, 2012. The purpose of the study was to compare 2 different balance training programs, based on distinct exercise frequencies, with the aim of improving proprioceptive ability. Thirty eight professional soccer players, were randomly assigned into 3 groups: the A group, exercised with a frequency of 6 times per week, for 3 weeks, the B group exercised with a frequency of 3 times per week, for 6 weeks and the C group (control) did not follow a highly specific balance training, but only a standard soccer training. All participants were evaluated with the use of an electronic stability system (indices-deviations) and of a wooden balance board (time on balance) before (pre test) and after the training period (post test). Analyses of variance (ANOVAs), with repeated measures on the last factor, were conducted to determine effect of training programs and measures (pre-test, post-test) on balance test indices (SI, API, and MLI) and time on balance board. The results showed that both training groups improved their balance ability similarly ($p<0.05$) despite the different frequency of the balance training program. The authors proposed that balance training program can be applied in soccer players on a daily basis or at least 3 times per week, according to the demands of the training period. **Key words**: SOCCER PLAYERS, PROPRIOCEPTION, FREQUENCY OF BALANCE TRAINING.

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INTRODUCTION

Soccer is one of the most popular sports and attracts many participants all over the world (Peterson et al., 2000; Soderman et al., 2000). This huge participation though, leads to a substantial number of musculoskeletal injuries (Dvorak, 2000; Morgan & Oberlander, 2001). To prevent such injuries, rehabilitation specialists propose specific exercise programs like strengthening exercise programs to restore muscle imbalances, stretching exercise programs to decrease muscle stiffness, and balance exercise programs to improve proprioception (Caraffa et al., 1996; Askling et al., 2003; Malliou et al., 2004; Gioftsidou et al., 2006; Gioftsidou & Malliou, 2006).

Balance is generally defined as the ability to maintain the body's center of gravity within its base of support and can be categorized as either static or dynamic balance. Static balance is the ability to sustain the body in static equilibrium or within its base of support (Goldie et al., 1989; Olmsted et al., 2002). Dynamic balance is believed to be more challenging because it requires the ability to maintain equilibrium during a transition from a dynamic to a static state (Ross & Guskiewicz, 2004). Both static and dynamic balance require effective integration of visual, vestibular, and proprioceptive inputs to produce an efferent response to control the body within its base of support (Irrgang et al., 1994; Guskiewicz & Perrin, 1996).

In addition, Hanney (2000) states that proprioception is "the reception of stimuli produced within organism", whereas balance is "physical equilibrium" (Hanney, 2000). This means that proprioception is a neurologic process, while balance is the ability to remain in an upright position (Hanney, 2000). Balance exercises aimed at improving proprioception; train the brain to recognize the body's segment position every moment. Therefore, a balance exercise program will train proprioception pathways more effectively under competitive circumstances. Specifically, in order to prevent limb injuries, peripheral and central nervous system receptors (Hanney, 2000), mechanoreceptors within muscles, tendons, and ligaments have to be activated. Balance exercises seem to help this activation occur faster and more effectively (Sammarco, 1995). In other words, the goal of balance exercises should be to reduce the time between neural stimuli and muscular response (Zachazewski et al., 1996).

Furthermore, it is important that balance exercise programs improve proprioception not only during the rehabilitation phase, but also during the competition period. This means that balance improvement protects athletes from possible forthcoming injuries (Hoffman & Payne, 1995; Hrysomallis, 2007; McHugh et al., 2007).

That's the reason why many scientists (Bahr et al., 1997; Caraffa et al., 1996; Wedderkopp et al., 1999; Soderman et al., 2000; Malliou et al., 2004; Gioftsidou et al., 2006) support that balance exercises are essential to athletic performance and should be incorporated into an athlete's daily training. Research has shown that the frequent use of these exercises decreases musculoskeletal injuries (Caraffa et al., 1996; Wedderkopp et al., 1999), however, there were no studies measuring balance parameters and their possible improvements after an application of a specific balance exercise program in professional male soccer players. Also, there have been no researchers examining the optimal frequency of applying these protocols.

The rationale for the present study is to compare two balance programs with different frequency of application for their effectiveness in improving proprioception of the lower limbs: a daily balance program that lasted three weeks or a program that was applied 3 times /week for a period of 6 weeks.

MATERIAL AND METHODS

Considering that there is always a need for improving proprioception through specific exercise programs, this study examines which balance exercise frequency would be more effective in improving balance ability: a) 6 times a week for a 3 week period (group A) or b) 3 times a week for a 6 week period (group B) (Table 1). In other words the two experimental groups followed the same protocol (20min) but in different exercise frequency. The group C did not follow a highly specific balance training, but only a standard soccer training and was settled as a control group. The control group was used in order to check if the soccer training alone can improve balance ability significantly. The participants of the C group were informed that they will perform the same balance training program 2 months later (after the final balance measures). The main question of the study was, which one will be more effective in improving postural control and train the brain to recognize the segment position, the was applied daily for a 3 week period, or the other one that was applied 3 times a week for a 6 week period.

Table 1. Contents of the balance training program.

Drills performed on: a) hemi-cylindrical board, b) hemi-spherical board
1st drill heading (2 reps of 45 sec per leg)
2nd drill leg passing (2 reps of 45 sec per leg)
3rd drill heading and leg passing alternate (1 reps of 1min per leg)
4rth drill: Control and leg passing (1 reps of 1min per leg)

Participants

Following written, informed consent from each player and clearance from the university human subjects committee, thirty-eight professional soccer players participating in the championship of the first Greek division, volunteered to participate in this study. The subjects had a mean age of 22.7±3.5 years, a mean weight 76.2±4.9, and a mean height of 1.79±6.36. None of the subjects were participating in any other physical activity except the soccer training and the balance training. Also, they were free from injury in their lower limb and had no mechanical or functional instability in their knee or ankle in that period, so they were participating in regular soccer training. In addition, no subject reported suffering from any systemic or vestibular-system disorders known to impair cutaneous sensation or balance. According to the team physician they did not have any biomechanical abnormality and had no other balance training activity prior to and during the entire research period.

Leg dominance was determined through the ball kick test. The players were asked to kick a soccer ball as hard as possible. The leg used to kick the ball was recorded as the dominant leg (Hoffman & Payne, 1995; Soderman et al., 2000).

Measures

The testing equipments that were selected to evaluate the 3 groups were an electronic stability system (Biodex stability system), a wooden balance board with hemi-cylindrical bottom surface, and a stopwatch. Procedures were in accordance with ethical standards of the Committee on Human Experimentation at the Institution at which the work was conducted and with the Helsinki declaration of 1975.

Deviations from the horizontal plane

Biodex stability System is a postural stability assessment and training system, which assesses the ability of the body to balance on an unstable platform (Arnold & Schmitz, 1998; Biodex Stability System, 1998). All subjects completed a single leg dynamic balance assessment for both limbs (dominant and no dominant).

For each test trial, subjects were asked to stand on a single leg on the platform with both arms across their chest and with the unsupported limb held in a comfortable position so as not to contact the test limb or the test platform. The subject's chosen test position was used for all practice and data collection trials. Instructions were given for the subjects to focus on a visual feedback screen directly in front of them (Rozzi et al., 1999).

The subjects tried to maintain the unstable balance platform on the horizontal position. Any balance platform deviations where reported numerically by the system in degrees. More specifically, the system provides three different indices according to the direction of the deviations from the horizontal plane; the total stability index (SI), the anterior -posterior index (API) and the medial-lateral index (MLI).

The participants were tested in the stability level 1 (less stable) and performed three 20 sec practice trials and three 20 sec test trials out of which only the best score was recorded. The participants performed three practice trials and three test trials out of which only the best score was recorded. The reliability has been established with intraclass correlation coefficients (ICC) for the soccer players. The ICCs for the first target was 0.80, for the third was 0.77 and for the sixth target was 0.67. Similarly ICCs values reported by Lephart on the manual of the Biodex Stability System (Lephart et al., 1998).

Balance boards tests

The balance board consisted of a flat wooden box 35 cm by 35 cm and 1 cm height in the middle of its under surface was located a hemi cylindrical hardwood block (35 length and 6 cm height).

The balance maintenance time of the subjects was recorded on the balance board with hemi-cylindrical bottom. They tried to maintain the board as stable (contact point only the cylinder) as possible avoiding any contact of the board edges with the ground, performed one time for anterior –posterior free motion (placed the cylinder parallel to frontal plane), and the other time for medial lateral free movement (placed the cylinder vertical to frontal plane).

For each test trial, subjects were asked to stand on a single leg on the balance board with both arms across their chest and with the unsupported limb held in a comfortable position so as not to contact the test limb or the balance board. The subject's chosen test position was used for all practice and data collection trials.

Their effort stopped when one of the edges of the board touched the ground. The participants performed three practice trials and three test trials out of which only the best score was recorded. The reliability has been established for soccer players with intraclass correlations coefficients (ICC). The ICCs for anterior – posterior motion were 0.72 and 0.67 for the dominant and non-dominant limbs respectively. For the medial-lateral motion the ICCs were 0.75 for the dominant and 0.69 for the non-dominant limb (Gioftsidou et al., 2006).

The 38 soccer players were randomly assigned in 3 groups, 2 experimental groups (13 participants each) undergoing the soccer training and the additional balance program and 1 control (12 participants) that did not follow a highly specific balance training, but only a standard soccer training. The testing procedure was followed by a training period for the 2 groups (by a training period of 3 weeks for the group A and of 6 weeks for the group B). The post-training testing performed at the end of the third week for the group A, and at the end of the sixth week for the group B and C.

Description of the balance exercise program: The exercise program was designed using principles from elite athlete training programs and those designed for rehabilitation of injured athletes with functional instability of their ankles or rupture of the anterior cruciate ligament. The main goal while designed the exercise program was to include skills that improve awareness and knee control during standing, cutting jumping and landing, which are important soccer technical elements. The balance exercises were performed for 20 minutes on two wooden balance boards: one board with hemispherical bottom surface and the other with hemicylindrical bottom surface (Table 1). All the exercises performed randomly for each limb.

Dependent variables were the "balance performance" in the initial pre and post tests of the lower limbs. The independent variable was set as the "group" that corresponds to the 3 groups (the group A with daily program, the group B with 3 times a week program, and the group C no balance training).

Analysis

The best time values were collected for each test. Means and standard deviations were calculated. Analysis of variance (ANOVA) for repeated measures was performed on recorded times to detect differences in each group for each limb. Statistical significant was accepted at $p<0.05$.

RESULTS

Analysis of the data illustrated that both training groups demonstrated significant improvements on Biodex stability tests, in SI ($p<0.05$), API ($p<0.05$) and MLI ($p<0.05$) for the dominant and no-dominant limb as well (Table 2). Similarly for the balance board, the results revealed for both training groups significant improvements ($p<0.05$) for the dominant and no-dominant limb (Table 3). No difference ($p>0.05$) in balance ability was found in the control group between baseline testing and re-testing. Comparing the two experimental groups, the results showed that there was not significant difference in balance ability improving $p>0.05$.

Table 2. *Means (M), standard deviations (± SD), and percentual differences for total (SI), anterior-posterior (API) and medial-lateral deviations (MLI), for the dominant (dom) and no-dominant (no-dom) limb (Biodex Stability System).*

	Group A			Group B			Group C		
Deviations	**Pre-training**	**3rd Week**	**%**	**Pre-training**	**6th Week**	**%**	**Pre-training**	**6th Week**	**%**
	M±SD	M±SD		M±SD	M±SD		M±SD	M±SD	
SI dom	9.6±2.4	6.1±0.8*	36.4	9.0±2.2	7.6±1.6*	15.5	9.2±2.4	8.7±1.5	5.4
SI no-dom	8.1±2.5	6.2±2.4*	23.4	8.4±3.0	6.6±2.0*	21.4	8.5±3.1	8.6±2.1	-1.2
API dom	7.7±2.3	5.6±1.1*	27.3	8.2±3.1	6.3±1.6*	23.2	8.1±3.3	8.1±1.5	0
API no-dom	6.9±1.9	5.3±2.1*	23.2	8.0±2.8	6.4±1.8*	20	8.4±2.9	8.2±1.9	2.4
MLI dom	4.9±1.2	3.7±1.0*	24.5	5.4±1.3	3.5±0.9*	35.2	5.3±1.5	5.2±0.8	1.9
MLI no-dom	4.4±1.2	3.3±1.2*	25	4.9±1.6	3.1±0.8*	36.7	4.7±1.4	4.8±0.9	-2.1

**p<0.05*

Table 3. *Means (M), standard deviations (± SD) and percentual differences of the balance board maintenance time for the anterior-posterior (APM), and medial-lateral movements (MLM), for the dominant (dom) and no-dominant (no-dom) limb.*

Time (sec)	Group A			Group B			Group C		
	Pre-training	**3rd Week**	**%**	**Pre-training**	**6th Week**	**%**	**Pre-training**	**6th Week**	**%**
	M±SD	M±SD		M±SD	M±SD		M±SD	M±SD	
APM dom	3.6±2.4	10.6±7.3*	294	2.5±0.7	9.6±3.1*	384	2.6±0.7	2.6±1.1	0
APM no-dom	3.0±1.6	7.1±2.2*	236	2.6±1.8	11.4±6.7*	438	2.8±1.8	2.4±2.1	-14
MLI dom	2.7±1.6	15.2±8.1*	562	3.3±1.7	17.1±12.1*	518	3.3±1.7	3.1±1.1	-6
MLI no-domi	3.0±1.6	17.8±7.8*	5.933	3.5±1.8	19.3±14.2*	551	3.5±1.8	3.3±1.2	-5.71

**p<0.05*

DISCUSSION

The results of this study showed that both balance training frequencies were effective in improving balance ability for both lower limbs, adding another important parameter in designing balance exercise programs. Although a lot of studies propose that these exercises can increase balance ability because of the injury rate reduction recorded (Caraffa et al., 1996; Chong et al., 2001; Wedderkopp et al., 1999; Gioftsidou et al., 2004), there were found no studies measuring balance parameters and their possible improvements after an application of a specific balance exercise program in professional soccer male players.

More specific, reductions of injury rates on professional athletes after the application of balance exercise program have been recorded by many authors. Caraffa and his partners (Caraffa et al., 1996) in a prospective controlled study of 600 soccer players mentioned the positive effects of a specific 6 weeks (3 times per week) balance-training program on the decrease of ACL injuries. This program had a gradual difficulty, and was applied on three hundred healthy soccer players (training group), 20 min per day, for three seasons. The results showed that the training group presented only the 13% of the injuries of the control group. Similarly, Wedderkopp and his partner (Wedderkopp et al., 1999) mentioned that the application of a balance training program on balance boards by healthy female handball players, for 10 months resulted in decrease of frequency of lower limb injuries.

As regards the assessment of balance ability after an application of a specific balance exercise program there were studies performed not on professional athletes but on healthy people. Hoffman and Payne (1995), investigated the effects of ankle disk training (BAPS) on postural sway of healthy subjects (n=28) and showed significant improvements. They concluded that 10-weeks of proprioception ankle disk training can decrease postural sway parameters significantly. Chong and his partners (2001) applied also a balance program on healthy people using balance boards (4 weeks, 3 times per week). The program was carried out and the participants improved their balance ability.

As concerns the content of balance training programs, which applied on healthy athletes, it has been supported that they should be adjusted to the peculiarities of each sport, simulating its activities (Tippett & Voight, 1995; Rozzi et al., 1999; Wedderkopp et al., 1999; Gioftsidou & Malliou, 2006; Paillard et al., 2006; Ricotti et al., 2011; Ricotti, 2001). For that reason, many researchers designed balance training programs that included soccer skills while the player was standing on balance board (Caraffa et al., 1996; Soderman et al., 2000; Gioftsidou et al., 2006). The design of the balance programs used in the present study is in accordance with the above theory. The specific balance exercises required the combination of balance ability and certain soccer skills, like kicking and header. According to the present study design, both training groups performed the same exercises and although frequency was different, their balance ability was equally improved.

In conclusion, the application of a 20-minute balance-training program, for at least 18 training sessions, can improve body control and increase proprioceptive ability. The daily balance program and the program with a frequency of 3 times per week had the same result in balance improvement. Therefore, the soccer-coach is able to select the appropriate frequency of balance exercise according to its own training schedule, knowing that the effectiveness is equal for both frequencies.

CONCLUSIONS

The frequency of the balance training program could be adapted to the season's soccer training design. More specific, the content, the duration and the frequency of the soccer training are depended from the specific training season (preparation, competition). More specific, during the preparation period the coach have plenty of time and usually can apply two training sessions daily. In that period soccer players could perform balance exercises daily. In contrast, at the competitive period the team give one or two matches every week (cup matches), so can accomplish only two or three completed training sessions per week. In that case, soccer players could perform balance exercises 3 times per week. Thus, the coach, according to the week training plan, can choose the appropriate frequency of the balance training program, knowing that the same result in balance improvement will be achieved.

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