Original Article

Effect of proprioceptive training and central stabilization in physical fitness in young soccer players

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Abstract:

The aim of the study was to evaluate and compare the effects of proprioceptive training (PT) and central stabilization (CS) related to physical fitness in young soccer player athletes. Twenty-four male athletes randomly divided in two groups (PT: 15.6 ± 0.5 years old; CS: 15.3 ± 0.5 years old) participated in the study. The assessment was made by the Square Test (agility), Sit Up (abdominal strength), Side Hop (balance), Shuttle Run (speed) and Flexibility (Wells Bank). The intervention totaled nine weeks, three times a week. The data analysis was performed using the Wilcoxon Test. At the end, all athletes showed improved speed. In PT there was also an improvement in agility. However, when comparing methods, the PT group showed better results related to agility and the CS related to speed. Thus, the results show the importance of Sports Physiotherapy, influencing in a positive manner in the athletes' physical fitness.

Key words: athletes, physiotherapy, sports.

Introduction

Soccer is currently considered the most popular sport, and research show that, worldwide, there are about 200 thousand athletes playing it professionally and 240 million as non-professional players (33). Soccer is a team sport and its practice involves specific techniques, game tactics and several skills such as, jumping, running, rapid acceleration, sudden stops, speeding and shots (1, 6). The improvement of these attributes is the key in achieving the aim of the game, scoring goals in the opposing team (7). The possibility of scoring a goal comes from short or long passes which require accurate technique combined with speed in the running movement (2). A large part of these actions is performed in shots touching off a swift move with quick ball passes and this is considered the best tactic propriety to obtain good results in the game (29). In addition, a fast kick is able to cause the ball to move fast and it can affect the reaction time of the goalkeeper, increasing the success rates in scoring a goal (29). Therefore, one of the main training objectives is to improve the techniques of kicks, passes and to increase the running speed of soccer players. Thus, the factors which influence the running speed and ball kicking have been the object of study in several research (21, 17, 19). The results suggest that the final length of the pitch before touching the ball, position of torso and arm alter the shooting speed (17). It was also found that the ball's speed may be affected by characteristics, such as strength, coordination of the lower limbs and technical capacity in small children who are still in their development period (21). Thus, a possible strategy to maximize the performance of this condition in soccer would be proprioceptive training (PT) or central stabilization (CS).

Proprioception comprises balance as a dynamic episode comprising a combination of primary stability and mobility to maintain a position in space or to move in a controlled and coordinated manner (3). Central stabilization is admitted as a biomechanical support efficient in maximizing the strength between the static stabilizers maintaining an effective posture (25). These features are directly linked to the sport performance and largely related to features such as, strength, speed, coordination and speed which are hardly developed simultaneously and/or prioritized in conventional physical training (4, 9). Recently it has been suggested that a sensorimotor training helps to improve power, strength and jumping ability in untrained individuals, but recreationally active (14, 20). However, there are other evidences reporting no increase in strength development rates with the sensorimotor training (10, 30). In this context, we can perceive that the results are still conflicting moreover this issue was little analyzed in individuals practicing soccer trying to disclose improvements in speed and agility. The implement of these types of training, the possibility of improving the specific ability of the sport together with increases in running speed is promising and they can be of great value for the prescription of technicians. Thus, the aim of this study was to evaluate and compare the effects of proprioceptive training and central stabilization related to physical fitness in youth soccer player athletes.

Methods

Participants

The sample consisted of 24 young men who were selected from a group of soccer players in the youth category with similar physical exercise levels (2 or 3 times a week), training history (3 years practice), active at the non-professional youth soccer leagues, aged from 14 to 17 years old. The players would be excluded from this study case if they had previously been involved in a formal program of neuromuscular and/or central stabilization training, presented a lesion in the last six months, recent postoperative and/or continuous use of any controlled medication. All participants and their parents were told about the purpose, content and the risks of the study before the investigation. The release to participate was given only upon signing the free and clarified consent term by players and the permission term from the parents for children under 18 years old. The participants' personal information such as, years of practice, training weekly frequency and medical history were obtained from the parents through a questionnaire. The Ethics Committee from Dom Bosco College, CAAE, approved the current study: 35110414.3.0000.5223.

Table 1. Anthropometric characteristics of CS and PT training group.

Variables	CS	PT
Age (years)	15.32 ± 0.51	15.60 ± 0.50
Body Mass (kg)	74.13 ± 7.34	70.40 ± 8.75
Height (m)	1.78 ± 0.04	1.75 ± 0.07
BMI (kg/m ²)	23.43 ± 2.08	22.88 ± 2.29

BMI: Body Mass Index

Protocol

Curitiba and metropolitan area (PR) soccer players were randomly divided in two groups: PT (n = 12) and CS (n = 12). Both groups took the Square Tests (agility), Sit-Up (abdominal strength), Side Hop (balance), Wells Bank (flexibility) and Shuttle Run (speed) at the beginning of the intervention and at the end. These tests, as well as the anthropometric variables were measured after 48 hours of consecutive rest in order to avoid the deleterious effects of fatigue, which would result in performance reduction affecting the results. Familiarity with the PT and CS protocols lasted one week for each one, and after finishing this procedure, the training program continued. The intervention totaled nine weeks, three times a week, which occurred in the morning, not conflicting with the technical and tactical training of the athletes. The PT protocol initially used a set of bilateral exercises of the lower limbs progressing to unilateral and CS played in the strengthening of the abdominal area through isometric stimulus in the plank position graduating the difficulty too. The implement of difficulty both in the PT and CS exercises were only made after three consecutive weeks of performing the same routine, respecting the principle of adaptation to training. The groups maintained their soccer training routine, being accompanied by the same coach throughout the study. The PT and CS protocols were applied on the days that there were not technical and tactical training to avoid possible interference and/or income reduction. The protocols were developed at different times and both had a three times a week frequency (Monday - Wednesday - Friday) totaling 27 meetings, that is, nine weeks of training. Warm-up was standardized for both groups, which constituted in a light walk - moderate (3 minutes) followed by a trot (3 minutes) and several callisthenic movements (8 - 10 minutes). In the CS protocol, different exercises were performed, being that in each one of them the participants should maintain for 30 seconds an isometric contraction of the transversus abdominis, multifidus and pelvic floor muscles. This movement routine suffered an implement in the difficulty level every three weeks in order to maintain appropriate stimuli as recommended to the adaptation principle to training. The first week, three sets of 30 seconds of static bridge, plank and upper chest push-ups, on Wednesday, kept the volume progressing with the same exercises for unstable surfaces with static dynamic positions, bipedal and unipedal movements; in the seventh week there was an increase of 30 seconds in the length of staying in the same positions (Figure 1).

Fig. 1. The different EC progression levels.

In PT they were submitted to exercises that caused instability in which, they would remain for 30 seconds trying to stabilize the position and in case they would unbalance they would return to the movement

until they fulfilled the remaining time. This protocol also graduated its movement difficulty and stay duration in the position every three weeks applying the same amount of exercises and number of sets, presenting a total volume of training equal to CS. All participants received instructions on proper hydration and recommendations to consume light food before training protocols (Figure 2).

Fig. 2. The different PT progression levels.

Statistical Analysis

Descriptive statistics was used to present the data from this study through the mean and standard deviation. The data were first subjected to the Kolmogorov-Smirnov test identifying that the variables did not present a normal distribution and following the Wilcoxon test was used with dependent samples and the Kruskal Wallis test in the independent, and finally, the Tukey post hoc was performed. For the statistical treatment it was used the SPSS 21.0 with significance level $p < 0.05$.

Results

The Wilcoxon analysis revealed a significant difference ($p < 0.05$) between the pre and post-intervention in the CS group for speed.

Table 2. Pre and post-intervention in the CS group.

	Pre-test	Pos-test
Agility	$6,5 \pm 0,6$	$6,4 \pm 0,4$
Abdominal Strength	$53,2 \pm 4,3$	$52,7 \pm 4,1$
Balance	$12,3 \pm 0,8$	$11,8 \pm 0,5$
Flexibility	$29,6 \pm 7,7$	$29,1 \pm 4,8$
Speed	$7,6 \pm 0,5$	$6,2 \pm 0,4^*$

* $p < 0,05$

PT also showed a significant difference ($p < 0.05$) in the pre-test and post-test for speed and agility.

Table 3. Pre and post-intervention in the PT group.

	Pre-test	Pos-test
Agility	$6,5 \pm 0,4$	$6,2 \pm 0,31^*$
Abdominal Strength	$54,2 \pm 4,1$	$55,5 \pm 3,8$
Balance	$12,0 \pm 0,7$	$11,7 \pm 0,9$
Flexibility	$31,1 \pm 4,4$	$31,9 \pm 5,8$
Speed	$7,7 \pm 0,9$	$6,4 \pm 0,4^*$

* $p < 0,05$

Table 4 shows the comparison between the groups in which, it was found a significant improvement ($p < 0.05$) in the PT post-test for agility in relation to the CS post-test (CS: 6.5 ± 0.6 vs. PT: 6.2 ± 0.3) and in the CS post-test implements for speed were identified when compared to the PT post-test (CS: 6.6 ± 0.4 vs. PT: 6.2 ± 0.4).

Table 4. Comparison of the variables pre and post-intervention between groups.

Variables	Pre-test		Pos-test	
	CS	PT	CS	PT
Agility	$6,5 \pm 0,4$	$6,5 \pm 0,6$	$6,4 \pm 0,4$	$6,2 \pm 0,3^*$
Abdom. Strength	$53,2 \pm 4,3$	$54,2 \pm 4,1$	$52,7 \pm 4,1$	$55,5 \pm 3,8$
Balance	$12,3 \pm 0,8$	$12,0 \pm 0,7$	$11,8 \pm 0,5$	$11,7 \pm 0,9$
Flexibility	$29,6 \pm 7,7$	$31,1 \pm 4,4$	$29,1 \pm 4,8$	$31,9 \pm 5,8$
Speed	$7,6 \pm 0,5$	$7,7 \pm 0,9$	$6,2 \pm 0,4^*$	$6,6 \pm 0,4$

PT = Proprioceptive, CS = Central stabilization, * $p < 0,05$

Discussion

Result analyses of this research showed that both trainings promoted improvements in the athletes' speed. However, when they were compared between themselves, PT showed a significant improvement in agility and CS showed a difference for speed (Table 4).

Agility is considered a physical valence that makes up speed, characterized by sudden changes of direction (start and stop) with the support of the body's correct position (18, 28). This skill is governed by articulate proprioceptive receptors which are related with sensations of position and direction of movement being sensible to the variations of angular amplitude and speed, as well as the intra-articular pressure (18, 28, 26). This allows the central nervous system the ability to monitor the effect of its commands, in a feedback mechanism, until the movement is finished (22).

Soccer players during a specific training and/or an official game perform high speed runs with constant changes in position and direction, that is, they have agility, as well as, a well-developed proprioception. Despite this fact, this study showed that the PT implement is able to improve this skill even more. Possibly, the improvement happened in detriment to the specific development of the stability of articulation, conscience of position, movement, neuromuscular control and primordial mobility which were not worked with the athletes (25, 3). Furthermore, the increase of these skills, possibly also justifies the improvement observed in the speed test performance.

On the other hand, the CS training only obtained significance for the speed test not being efficient in the improvement of agility, although, the central stability of the pelvic loin complex prevents and returns the equilibrium after being perturbed, similar to PT. Hodges and Richardson (12), verified through electromyography, the activity of the abdominal muscles and multifidus during the lower limbs movements, concluding that the trunk muscles activity occurs before the beginning of the lower limbs movement independent of direction. This condition produces a firm foundation of the lower limbs movements, leaving them more harmonious and efficient. This leads us to believe that this dynamic development of the trunk and pelvis allowed greater acceleration, deceleration and dynamic stabilization, which reflected positively on the speed performance.

Regarding balance, some studies have shown that physical exercise programs to stimulate the proprioceptive sensory paths can improve this aptitude (24, 32). However, this was not observed in the present findings. This result was due to the prevalence of visual signs, that is, when the central nervous system (CNS) orders the afferent of the visual system, vestibular and proprioceptive to perform the balance control, the visual overreach the other two to provide information (27, 16). Thus, the test performance in open eye condition is possible that the balance control has been mainly affected by the visual system feedback, to the proprioceptive detriment, not revealing the possible improvement of the proprioceptive answers after the proposed training (15). Flexibility and abdominal strength also showed no significant difference, probably, by doing specific training of flexibility as well as abdominal strength in their regular routine.

In conclusion, the results of this research showed the importance of Sports Physiotherapy in sporting associations, positively influencing the athletes' sport physical fitness. It was found that proprioception training is more appropriate than central stabilization, since it acts in a global way, influencing in greater efficiency when compared to a specific training such as central stabilization that acts in the center of mass alteration, being this the great applicability of study practice.

Because it is a high-performance sport, soccer is a sport modality where the improvement of physical fitness is essential both for the athlete and for the team. Thus, it is evident the need to research for resources in the field of sports physiotherapy in order to deepen and expand these findings for this sport, seeking the athlete's best performance and physical fitness safely.

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