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INFLUENCE OF AN EXERCISE PROGRAM IN THE PERONEAL REACTION TIME

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Soccer is the most popular sport in the world and has characteristics which led to high incidence of injuries, which motivate FIFA to develop a program for injury prevention. The peroneal reaction time plays an important role in the prevention of the inversion movement in ankle injuries. This study's main goal is to verify if such a program promotes changes in the peroneal reaction time. This is a quasi-experimental study with 14 athletes, distributed in two groups, experimental and control. The results show some significant changes in the peroneal reaction time, in response to the exercise program.

KEYWORDS: peroneal muscles; soccer; fmarc; the 11+

INTRODUCTION: With over 250 million players worldwide, soccer is the most popular sport. Due to its strong physical contact, this sport has a high injury incidente, especially in the lower limbs, with great impact in the ankle joint (Mohammadi, 2007). The incidence of soccer injuries is between 12 and 35 occurrences per 1000 game hours and 1,5 to 7,6 injuries per 1000 training hours (Junge, et al., 2002).
The ankle sprain injury presents several risk factors, which may be classified as extrinsic or intrinsic. Among the intrinsic factors, the one that stands out most is the peroneal reaction time (PRT) (Fong, et al., 2009; Willems, et al., 2005).
The ankle sprain is the most common injury in professional and amateur practice, so it is important to develop exercise programs that incorporate a postural control component. On the ankle joint, the most important component is the peroneal muscle reaction time (Willems, et al., 2007; Mohammadi, 2007). This activation is the most important response in the movement of foot inversion, which is a peripheral reflex response of the peroneal longus and peroneal brevis muscles (Bryan & Lephart, 2002; Delahunt, 2007). However, a change in PRT between healthy and ankle injured subjects is controversial and inconclusive in bibliography, but there are studies that present significant changes with specific proprioceptive training programs (Karlsson & Andreasson, 1992; Delahunt, 2007; Vaes, Duquet & Van Gheluwe, 2002; Mohammadi, 2007).
In order to address the different aspects of injury present in soccer, the Fédération Internationale de Football Association (FIFA), through the FIFA-Medical Assessment Research Centre (F-MARC) has developed an injury prevention program, "The 11 +", without any emphasis on a specific type of injury. This program showed a reduction in the number of injuries, both in athletes of high intensity and low intensity training (Junge, et al., 2002).
It is urgent to realize the influence of this undifferentiated exercise program in peroneal reaction time, in order to ascertain its effectiveness. Therefore, the aim of this work is to determine changes in the peroneal longus and peroneal brevis reaction time, in the dominant limb, after the application of "The 11+".

METHODS: The study design fits into a quasi-experimental methodology, since the sample was not randomized. The population was composed of young soccer players from two different clubs, Sporting Clube de Coimbrões, experimental group (EG), and Clube Desportivo do Candal, control group (CG). After all stages of implementation and evaluation of the exercise program, the final number was fourteen athletes, seven in each group.

Table 1
Characterization of the sample with average age, height, weight and number of hours of weekly training. The *p* value are the result of the homogeneity test

	Control Group	Experimental Group	p
Age (years)	17.29±0.76	17.43±0.54	0.775
Weight (kg)	67.71±4.96	69.29±7.48	0.848
Height (cm)	173.14±4.10	176.43±5.62	0.402
Number of hours of weekly training (hours)	7.29±1.25	7.14±1.22	0.601

The sample shows homogeneity between groups, as shown in Table 1.
The inclusion and exclusion criteria were established by questionnaire. The inclusion criteria were: in competition, registered in the Associação de Futebol do Porto. The exclusion criteria were: previous history of ankle injury in the last 6 months (Fong et al., 2009); previous history of other injuries in the lower limb in the last 3 months (Wong & Hong, 2005; Eechaute et al., 2007); ankle instability, established through the Single Leg Balance Test (Trojian & Mckeag, 2006; Eechaute et al., 2007; Hopkins et al., 2009).
To obtain the PRT, the subject was placed on the home made instability platform, the Trapdoor, to promote the sudden inversion movement. When one of the openings was triggered, there was an interruption of the continuous analog signal; this interruption was detected by the Acqknowledge® software. The opening of the Trapdoor corresponded to an angle of 30 degrees in frontal plane (Hopkins, McLoda & McCaw, 2007; Benesh et al., 2000).
The PRT was obtained by electromyographic signal, using the Biopac system MP100WSW (Biopac Systems Inc., Santa Barbara, CA, USA), with a sample rate of 1000Hz. According to the most recent literature, the electromyographic detection of peroneal reaction time, after sudden inversion movement, has a coefficient of intra-class correlation (ICC) of 0.71 to 0.98, with mean standard error of 4.7 to 10 milliseconds. For the right tibiotarsal joint, the ICC is 0.71, (SEM=8,4 milliseconds) and, for left tibiotarsal joint, the ICC is 0.83, (SEM=6.3 milliseconds), comparable to the literature values (Eechaute et al, 2009; Eechaute et al, 2007).
After the sample selection, the evaluation of the PRT was made. This evaluation consisted in measuring the PRT before and after the implementation of the exercise program. The exercise program was applied during six weeks, three times a week, as suggested by Fong et al., 2009.
The FIFA's program was fully implemented and the difficulty levels were introduced every two weeks.
The electrode placement area was shaved, followed by the removal of dead skin cells and cleaning with alcohol. The peroneal longus electrode was placed 3 cm below the head of the fibula and the peroneal brevis electrode was placed 5 cm above the external malleolus. All the electrodes were attached with tape (Cramer®) (Benesh et al., 2000; Hopkins et al., 2007; Hopkins et al., 2009).
Three measurements were made in the dominant limb of each subject.
Informed consent was obtained for participation in the study, in the case of minors, from their parents, or in the case of adults, from themselves. The CG was informed that they would be given access to the same exercise plan following the completion of the study, if this was their intention.
Statistical analysis was performed using SPSS®, version 17. Tests used were nonparametric Mann-Whitney test for independent samples and Wilcoxon test for paired samples. All statistical tests were performed with a significance level of 0.05.

RESULTS: The statistical analysis performed showed there weren't any significant differences in the sample, before and after the exercise program (table 2).Table 3 shows the differences in each group, with the purpose to assess the evolution of the two groups.

Table 2
The *p*-value, mean and standard deviation for Mann-Whitney test

Variables	Sample	n	Mean±SD	p
PLRT mean before EP	Control	7	46.60±11.50	0.336
	Experimental	7	75.80±26.68	
PBRT mean before EP	Control	7	74.52±11.66	0.570
	Experimental	7	75.39±7.88	
PLRT mean after EP	Control	7	51.78±14.85	0.848
	Experimental	7	53.43±19.28	
PBRT mean after EP	Control	7	67.55±22.11	1.000
	Experimental	7	66.30±8.34	

PLRT, peroneal longus reaction time; PBRT, peroneal brevis reaction time; EP, exercise program; n, subjects number; M, mean; SD, standard deviation; p, p value to Mann-Whitney test.

Tabela 3
The *p* value, mean diffrence and standard deviation for Wilcoxon test

Variables	n	Mean±SD	p
PLRT difference of CG	7	3.82±13.52	0.917
PBRT difference of CG	7	13.60±23.48	0.273
PLRT difference of EG	7	26.56±18.82	0.043[1]
PBRT difference of EG	7	7.72±4.24	0.068

PLRT, peroneal longus reaction time; PBRT, peroneal brevis reaction time; CG, control group; EG, experimental group; n, subjects number; M, mean difference; SD, standard deviation; p, p value to Wilcoxon test.
[1] p value < 0,05.

In the experimental group there was a significant change in the mean of peroneal longus reaction time. In the same group, the peroneal brevis reaction time had a mean reduction, although not statistically significant.

DISCUSSION: In general, many of the exercises that are part of the program are accepted as enhancers of proprioceptive ability, but there isn´t enough research to certify which component is developed. The literature states that, in situations of ankle instability resulting from injury, the peroneal reaction time is affected, so it is important to know if the exercises presented respond to this need, so often seen in soccer players (Vaes, Duquet, & Van Gheluwe, 2002; Hopkins et al. 2009). The growing presence and intervention of the physiotherapist in sports leads to the need for tools that respond to these issues (Bulley & Donaghy, 2005).
“The 11+” program has no research published in the area of proprioception, but studies show that there is a significant reduction in the occurrence of injuries, without exploring which modifications are made at the level of injury factors (Soligard, et al., 2008).
The significant result (p = 0.043) observed in the peroneal longus may be a result of the exercise program implemented. The literature shows that proprioception programs, which are based on exercises in Freeman board, show significant results in improving the dynamic stability (Mattacola & Lloyd, 1997). Other authors found that proprioceptive programs, with several exercises directed to the ankle, reveal significant changes in peroneal longus and peroneal brevis reaction time, in subjects with instability (Eils & Rosenbaum, 2001). The result of this study corroborates the bibliography presented.

This significant result may be due to a change in neuromuscular spindles, by an increase in gamma motor activity, which leads to an improvement of motor control. However the central neuromuscular changes cannot be ruled out. The literature suggests that these findings may be a combination of central and local neuromuscular changes (Mohammadi, 2007).
Although a reduction of the mean peroneal brevis reaction time was shown, this reduction is not significant, probably because the sample number is reduced.

CONCLUSION: The study showed that there are slight changes in peroneal reaction time, more specifically in the peroneal longus reaction time, in response to "The 11+" exercise program.

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