COMPARISON OF THE ANAEROBIC POWER MEASURED BY THE RAST TEST AT DIFFERENT FOOTWEAR AND SURFACES CONDITIONS

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ABSTRACT

Introduction: Running anaerobic sprint test (RAST) has been considered a valid test for anaerobic evaluation. However, since the floor surfaces and footwear can affect some outcomes measured during exercise, this also can modify the RAST outcomes. Objective: Thus, the purpose of this study was to compare the RAST outcomes measured while wearing soccer cleats on grass ($RAST_{CG}$) and sneakers on a track ($RAST_{ST}$). Methods: Eight young male soccer players (Under-17 category; 16±1 years) participated in the study. The subjects performed two RAST on different days (recovery > 24h). The RAST test consisted of six 35-meter maximal runs with a 10-second recovery between each run. Running time during each effort was recorded to determine peak power (PP), mean power (MP) and fatigue index (FI); blood samples were also collected after each test for lactatemia determination ([Lac]). Results: PP (763.1 ± 87.2 W) and MP (621.6 ± 68.1 W) were higher in $RAST_{ST}$ than $RAST_{CG}$ (PP = 667.3 ± 67.0 W e PM = 555.9 ± 74.7 W), while [Lac] measured during $RAST_{ST}$ (7.3 ± 1.8 mmol.L^{-1}) was lower than measured in $RAST_{CG}$ (9.9 ± 3.2 mmol.L^{-1}). However, the FI did not statistically differ ($RAST_{ST}$ = 32.5 ± 8.3%; $RAST_{CG}$ = 34.1 ± 6.6%). Significant correlations were observed between MP values (r = 0.90) and between [Lac] values (r = 0.72). Conclusions: Thus, we can conclude that the RAST variables are affected by floor surface and footwear, with higher values being observed during $RAST_{ST}$ condition.

Keywords: anaerobic capacity, lactate and soccer players.

INTRODUCTION

The field soccer matches are divided in two sets of forty-five minutes each, characterizing a sports modality with predominance of aerobic metabolism. However, during its practice, the athlete is submitted to many high-intensity and short-duration situations, such as jumps, spins, alterations of direction and runs at maximal velocity, making the anaerobic metabolism (alactic and lactic) also highly demanded recruited for the performance of this modality[1]. This great anaerobic contribution results in a need to accurately measure this component in soccer for the monitoring of the training status of the athlete.

Therefore, the Wingate test (WAnT) is frequently used for the anaerobic power of soccer players[2-3]. Although the WAnT is considered a valid and accurate test for evaluation of anaerobic power, the main limitation of its application in soccer is that this procedure does not respect the ecological validity of the sport. Thus, the Running Anaerobic Sprint Test (RAST), due to its intermittent characteristic, seems to be a test closer to the activities performed by soccer players. The RAST consists in the performance of six maximal efforts in the 35 m distance intervaled with a passive recovery period of 10 s, where the same parameters measured in the WAnT[5] are determined. Additionally, Zagatto et al.[6] have recently demonstrated that RAST is a reproducible test and a good performance predictor in short-duration runs (35 to 400 m) and, since it is a simple test which uses running as means of locomotion, its introduction in the soccer training routine becomes viable.

Besides soccer players[7], the RAST has been used for anaerobic evaluation of basketball players[8], handball players[9] and active individuals[6]. Nevertheless, many studies have demonstrated the influence of different surfaces on the energy expenditure[10-12] and on the determination of physiological variables[13,14] as well as of exercise performed barefoot or with footwear[15]. Moreover, Brechue et al.[16] observed significant differences in the 40 m maximal performance on grass and on firmer surfaces, demonstrating hence the influence of different surfaces also on efforts with anaerobic predominance. However, few studies have evidenced the influence of different kinds of surface in efforts of short duration with short recovery intervals as the RAST.

Therefore, the comparisons between the values obtained in the RAST by soccer players and other modalities can be influenced by the evaluation conditions. However, studies which compare the values of anaerobic power derived from different surface conditions and footwear have not been verified in the literature. Thus, the aim of the present study was to compare the RAST values in different situations wearing sneakers on a track ($RAST_{ST}$) and at game conditions wearing soccer cleats on grass ($RAST_{CG}$).

METHODS

Participants

Eight soccer players from the under-17 category**,** mean age of 16.0 ± 1.0 years, height of 174.5 ± 3.7 cm, body mass of 64.8 ± 4.7 kg and VO$_2$max of 53.9 ± 5.0 ml.kg^{-1}.min^{-1} voluntarily participated in this study. The parents or legal tutors of all the athletes were informed on the risks and benefits of the present study and

only those who have agreed through the written free and clarified consent form were included in the analyses. The procedures of this study were approved by the ethics in research committee of the institution (# 2,982).

Experimental procedures

The evaluations were performed in two visits for the performance of two RAST, separated by a minimum period of 24h and maximum period of 72 h. In both visits the participants performed six maximum efforts of 35 m with 10 s of passive interval (RAST). On the first day, the participants performed anthropometric measurements followed by the RAST, wearing sneakers on an official track and field track ($RAST_{ST}$). The second visit was performed at similar time to the first visit and the participants performed the RAST wearing soccer cleats on grass ($RAST_{CG}$). Prior to the efforts application, the athletes performed 10-min warm up at both situations.

Running Anaerobic Sprint Test (RAST)

Prior to the efforts performance, total body mass of the subjects was measured, including the garments worn during the tests on a digital scale (TANITA UM080, Brazil). The RAST consisted in performance of six maximal runs of 35 m with 10 s passive recovery in between them. Each effort was timed (Timex®, model 85103). Absolute power (Pabs) was determined in each run through time (t), distance (D) and body mass (BM) checking of the individual (Pabs (W) = $(MCxD^2)/t^3$)

The peak power (PP), mean power (MP) and minimum power (Pmin), presented both in relative ($_{REL}$) and absolute values ($_{ABS}$) of body mass, as well as the fatigue index (FI) (FI(%) = (PP – Pmin) x 100) / PP) were adopted as the RAST variables. Moreover, maximum velocity (V_{MAX}) and mean velocity (V_{MED}) were determined through the distance and effort time ratio.

At the end of the sixth effort, at the two situations, blood samples (25 µl) were collected from the earlobe of the participants using capillaries previously calibrated and heparinized. The samples were immediately placed on reagent bands (BM-Lactate) and analyzed in a portable lactometer (Accusport®, Boehringer Mannheim GmbH®,GER).

Statistical analysis

The results are presented in means ± standard deviation. Data normality was tested and confirmed with the Kolmogorov-Smirnov test. Comparison of the parameters in the six efforts at both situations was analyzed through one-way ANOVA variance analysis for repeated measures, followed by Tukey post hoc. The Student's t test for dependent samples was used for differentiation between power of each effort as well as for comparison of the parameters derived from the RAST at the different footwear and surface conditions. The possible associations were verified with the Pearson correlation test. All analyses were performed through the STATISTICA 7 statistical package (Statsoft, USA), and in all cases the significance level was set at p < 0.05.

RESULTS

The total effort time was significantly higher (p < 0.05) at the $RAST_{CG}$ ituation (31.6 ± 1.6 s) than in the $RAST_{ST}$ situation (30.4 ± 0.9 s).

Additionally, at the $RAST_{ST}$ situation the V_{MAX} (7.4 ± 0.2 m.s^{-1}) and V_{MED} (6. ± 0.2 m.s^{-1}) were higher (p < 0.05) than the ones observed at the $RAST_{CG}$ situation (7.1 ± 0.2 and 6.6 ± 0.3 m.s^{-1}, respectively). Moreover, the PP_{ABS}, PP_{REL}, MP_{ABS}, MP_{REL} and [Lac], were higher (p < 0.05) at the $RAST_{ST}$ situation when compared to the $RAST_{CG}$, which did not occur with the FI (table 1).

The power measured in the six runs (E1, E2, E3, E4, E5 and E6), demonstrated both in relative and absolute manners concerning the body mass, presented similar behavior. Significant decrease in the power values was observed in the first run from the E3 at the $RAST_{CG}$ situation. However, at the $RAST_{ST}$ situation decrease from the E4 was evidenced, which demonstrates lighter sudden decrease of power generated at this situation. Furthermore, power, velocities and time in the E1, E4, E5 and E6 were significantly different between situations (figure 1).

Concerning the correlations between the variables originated from the RAST at the two studied situations, only the MP_{ABS} (r = 0.90), MP_{REL} (r = 090), V_{MED} (r = 0.90) and [Lac] (r = 0.72) were significant correlated.

Table 1. Peak power (PP); mean power (MP); fatigue index (FI) and lactate peak concentration (Lac) obtained in RAST wearing skeakers on the track ($RAST_{ST}$) and cleats on grass ($RAST_{CG}$).

|	$RAST_{ST}$	$RAST_{CG}$
PP (W)	763.1 ± 87.2	667.3 ± 67.0*
PP (W.kg^{-1})	11.7 ± 1.2	10.3 ± 1.1*
MP (W)	621.5 ± 68.1	555.9 ± 74.7*
MP (W.kg^{-1})	9.6 ± 0.8	8.6 ± 1.2*
FI (%)	32.4 ± 8.2	34.0 ± 6.6
[Lac] (mmol.L^{-1})	7.8 ± 1.8	9.8 ± 3.1*

* Significant difference concerning $RAST_{ST}$ (p lower than 0.05).

DISCUSSION

The main findings of the present study demonstrate that performance in the $RAST_{ST}$ situation was significantly higher than at the $RAST_{CG}$.

Zagatto et al.[6], when assessed 17 moderately active individuals on a 400 m track, observed PP values (695.4 ± 107.4 W) and MP (555.2 ± 77.30 W) similar to the ones found at the $RAST_{CG}$ situation. Values close to PP (649.9 ± 82.7 W) and MP (529.3 ± 69.7 W) were also found for handball players[9]. However, when the power obtained by these two studies is compared with the one determined at the $RAST_{ST}$ situation, it is observed that the values of the present investigation are higher. Thus, when comparisons are performed on the same surface ($RAST_{ST}$), soccer players may present higher absolute anaerobic power values and the RAST application on grass may underestimate the real power generated by the lower limbs in this test.

It has been demonstrated that that the energy expenditure for running may be influenced by the surface, presenting higher values on sand[10-12] and grass[17] when compared with firmer surfaces. Thus, the higher energy expenditure found on sand is attributed to factors such as decrease in use of elastic energy and efficiency of the muscle-tendon complex[10,11]. In addition to that, Sassi et al.[17] have recently determined higher energy expenditure for running on grass (5%), especially due to the higher impact absorption observed on this terrain (35%). Therefore, in the present study the lower stiffness presented at the $RAST_{CG}$ situation may have led to higher energy
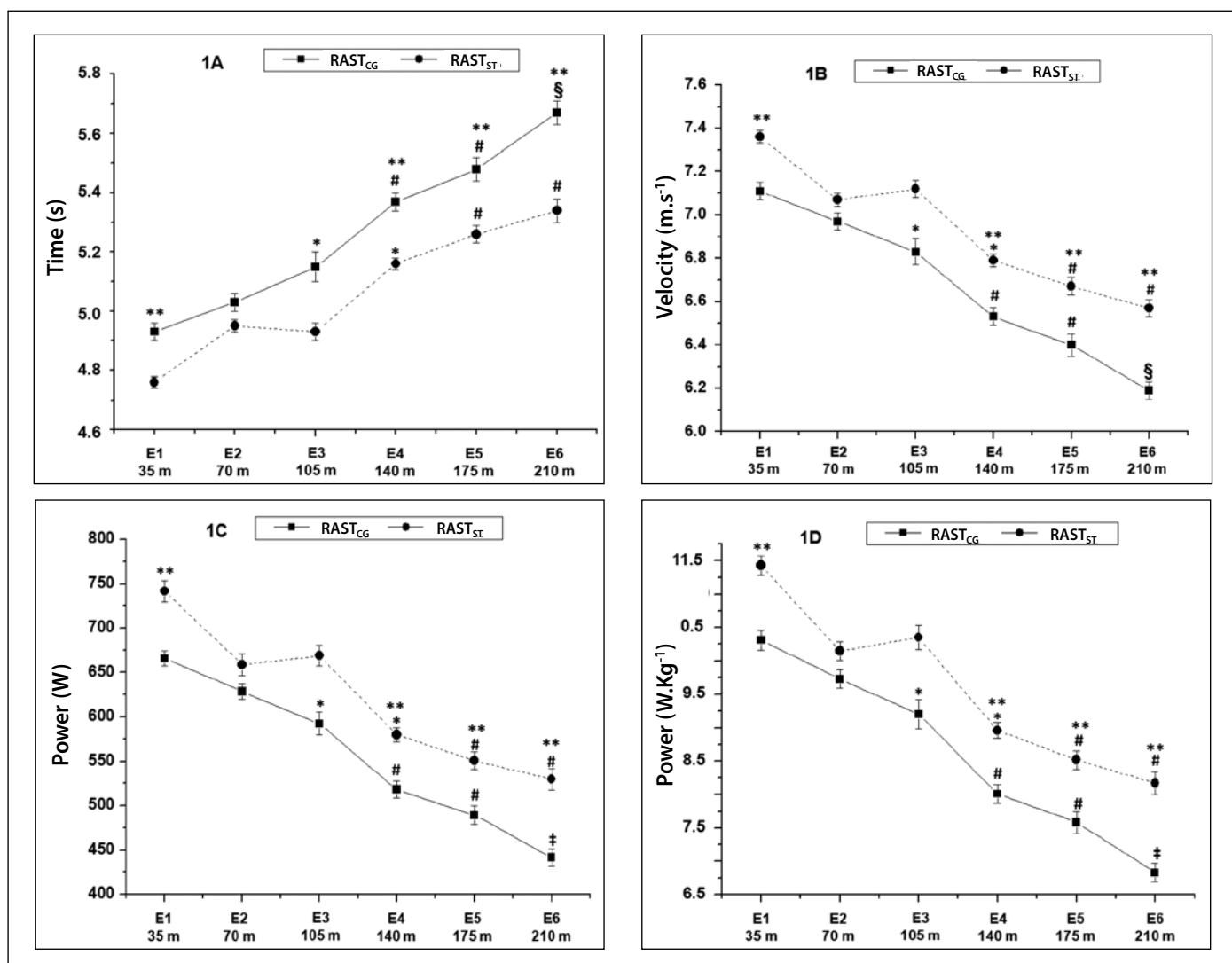
Figure 1. Means and standard error of the timings (A), the velocities (B) and the power developed, demonstrated in absolute (C) and relative manners (D) in the six RAST efforts performed on grass wearing cleats (RASTCG) and on track wearing sneakers (RASTST). E number of effort; * significant difference concerning E1 (p < 0.001); # significant difference concerning the three first efforts (p < 0.001); ‡ significant difference concerning E4, E3, E2 and E1 (p < 0.001); § significant difference concerning the five first efforts (p < 0.05); ** difference evidenced in the stage between the two situations.

expenditure for each run at that situation, increasing hence the total time and consequently resulting in worse performance in RAST at the $RAST_{CG}$ situation. Besides the surface, the use of different types of footwear may have influenced on the findings of the present study. Di Michele *et al.*[14], when compared the anaerobic threshold of 18 soccer players determined on treadmill and on natural grass did not observe significant differences when sneakers were worn at the two situations. However, Kunduracioglu *et al.*[13] determined that field soccer players may present lower anaerobic threshold values, determined on field with cleats compared with the one determined on treadmill and wearing sneakers. Brechue *et al.*[16] when wearing cleats on grass and sneakers on firmer surface have also observed significantly higher times on grass (5-6%) for 40 m maximal run, assessing American football players. Therefore, the use of cleats may have increased the time of contact with the ground, a factor observed in the 20 m velocity after induced fatigue[18,19] and associated with lower efficiency in the stretching/shortening cycle[20].

The outcomes obtained in the present study point out to a differentiation in the three last runs of the RAST between the evaluation conditions, besides more remarkable decrease in the power

and velocities of the $RAST_{CG}$ condition. Considering that the RAST is an intermittent effort; during the performance of the maximal efforts (~5s), the energy needed is mainly obtained from anaerobic sources[21]. Therefore, performance in the subsequent efforts is mainly determined by the recovery of phosphocreatine supplies (PCr), lactate and intracellular inorganic phosphates removal (Pi), processes which are performed during the recovery periods by the aerobic metabolism[22]. However, it has been demonstrated that intervals longer than 10 s are necessary for satisfactory PCr recovery[23]; thus, the period between each effort in the RAST was probably insufficient to restore this substrate, leading to gradual decrease of the power and velocity obtained.

Moreover, the hypothesis that efforts performed on grass with cleats lead to greater use of the PCr supplies can be sustained by the higher [Lac] observed at the $RAST_{CG}$ situation. This fact mainly occurs due to greater activation of the glycolytic pathway after the decrease of the PCr concentrations, in an attempt to maintain the ATP production satisfactory[24]. Additionally, greater use of ATP and activation of the lactic metabolism, metabolites such as lactate and hydrogen ions have their muscular concentration increased, which

has been associated with fatigue in this kind of effort[25]. On the other hand, many studies demonstrated that in intermittent efforts glycolysis is inhibited[26-28]. Nonetheless, Glaister *et al.*[29] observed higher [Lac] in intermittent efforts with 10 s of interval compared with the ones performed with 30 s of interval, evidencing the need for further studies dealing with the glycolysis role in this kind of exercise.

Although the literature has reached a consensus about energy expenditure and the mechanical characteristics of the running on different surfaces, the present study did not perform direct measurements of these variables during the RAST runs. However, the differences found on the studied surfaces are relevant since they present the limitation in the RAST comparisons at different assessment conditions.

CONCLUSION

The findings of the present study suggest that for soccer players the power obtained through the RAST can be influenced by the evaluation conditions, presenting lower values at the $RAST_{CG}$ situation in comparison with the $RAST_{ST}$, probably due to the higher metabolic demand involved at the first condition, evidencing the need for further studies which investigate the participation of the aerobic, lactic and alactic anaerobic systems during these efforts.

All authors have declared there is not any potential conflict of interests concerning this article.

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