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Section II - Exercise Physiology & Sports Medicine

Different Cleat Models do Not Influence Side Hop Test Performance of Soccer Players with and without Chronic Ankle Instability

by
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The lateral ankle sprain is one of the most common sport injury, representing 10-30% of all musculoskeletal disorders. The lateral ankle sprain is induced by sport gestures involving changes of direction and landing manoeuvres and constitutes a risk factor for the occurrence of chronic ankle instability. Although cleat models and performance have been already explored, no study has evaluated this relationship in athletes with chronic ankle instability. Therefore, the purpose of the study was to analyse the influence of different soccer cleat models on Side Hop Test performance of athletes with and without chronic ankle instability. Thirty-nine athletes were divided into two groups, a chronic ankle instability group (n = 20) and a healthy group (n = 19). Each participant performed the Side Hop Test, executing 10 consecutive jumps on dry artificial grass with 4 cleat models. The Qualisys System and two force platforms were used to analyse the test runtime, the distance travelled and the mean velocity. No statistically significant interaction was observed between the group and the cleat model for all variables evaluated. In addition, no differences were observed between models or groups. In this specific test, performance does not seem to be influenced by different cleat models on dry artificial grass in athletes with and without chronic ankle instability.

Key words: *soccer shoes, velocity, runtime, ankle sprain, artificial grass.*

Introduction

Soccer is the most practiced sport worldwide and is characterized by a variety of unpredictable movements involving rapid speed changes (Sterzing et al., 2009; Kalinowski et al., 2019). The evolution of modern soccer was accompanied by the development of artificial turf grounds, especially for non-professional competitions, and by the evolution of different cleat models (FIFA, 2012). This evolution highlights the study of cleat-surface interaction involving artificial turf grounds. A recent systematic review indicates that this interaction has a significant impact on the performance of several sports gestures (straight-line sprints and slalom, kicking and passing a ball) in healthy athletes (Silva et al., 2017b). However, according to our knowledge, no study has assessed the cleat-surface interaction in athletes with one of the most frequent postural control disorder – chronic ankle instability. In fact, about 25-41% of the athletes with episodes of the ankle sprain develop chronic ankle instability (CAI) (Tanen et al., 2014). These values are relevant since the ankle sprain,

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involving mainly damage in lateral ligaments (Doherty et al., 2014), is one of the most common injuries in sports, representing 10-30% of all musculoskeletal disorders and about 76% in soccer (Fong et al., 2007; Kobayashi and Gamada, 2014). Chronic ankle instability involves recurrent ankle sprains with residual symptoms and further induces instability (Al-Mohrej and Al-Kenani, 2016; Gribble et al., 2014). It has been argued that individuals suffer partial deafferentation following an ankle sprain, reducing reflex activity that would be initiated by joint mechanoreceptors (Herb and Hertel, 2014). A lack of proprioceptive information from partial deafferentation could chronically suppress gamma activation and desensitize the muscle spindle (Sousa et al., 2017). This mechanism has been interpreted as the basis of chronic ankle instability (CAI) and supports the high incidence of CAI following the ankle sprain (Sousa et al., 2017; Tanen et al., 2014).

Seeing the performance as one of the major athletes' concern (Hennig, 2011), it becomes relevant to study the factors that can influence this variable, not only in athletes without a history of ankle injury, but also in athletes suffering from CAI. The cleat-surface interaction has been the subject of several studies (Muller et al., 2010; Silva et al., 2017a; Sterzing et al., 2009; Sterzing et al., 2010), however, according to a recent systematic review (Silva et al., 2017b) this interaction was not evaluated in tasks closed to the ankle sprain injury mechanism such as jumps with changes of direction. Among the various features of the cleats, the sole importance has been highlighted and would have a significant impact on this task. The sole should provide enough traction to prevent slipping and to facilitate braking and changes of direction (Conenello, 2010). The diversity of cleats currently used on artificial grounds (Turf (TF), Artificial Grass (AG), Hard Ground (HG) e Firm Ground (FG)) (Hennig, 2011), emphasizes the need to identify which model provides better performance, since only the first two models are indicated by manufacturers as specific to this ground (Conenello, 2010; Silva et al., 2017b; Sterzing et al., 2009).

Considering the aforementioned arguments, this study aimed to analyse the influence of different cleat models on performance assessed with the Side Hop Test in soccer players with and without CAI. This test was selected because it involves jumps with changes of direction and has been proved to be highly demanding to detect functional-performance deficits (Caffrey et al., 2009; Docherty et al., 2005). The cleat model that provides a shorter runtime would be the best option in game situations that involve changes of direction in single support. Despite the lack of studies regarding the influence of these cleat models on performance of athletes with CAI (Silva et al., 2017b), since TF and AG models are recommended by the manufactures for artificial grass fields, it can be hypothesized that these models would be associated with better performance in both healthy and CAI athletes. It can be also hypothesised that athletes with CAI would take more time to perform the task, since this feature has been related to chronic ankle instability (Caffrey et al., 2009; Docherty et al., 2005).

Methods

An experimental within-subject study design was developed in a sample of federated amateur soccer players, with and without CAI. The test runtime, distance travelled and mean velocity were assessed as dependent variables, while the different cleat models were considered as independent variables.

Participants

Thirty-nine amateur male soccer players, with at least five consecutive years of official competition experience and aged between 18 and 30 years participated in this study. We only studied amateur players because compared to professional athletes (200 000), amateur players (240 million) represent the majority of practitioners (Valderrabano et al., 2014). Participants were divided into two groups, one included players without history of the ankle sprain or other musculoskeletal injuries (a healthy group, 21.21 ± 3.28 years old, n = 19) and the other included players with CAI (a CAI group, 20.70 ± 2.49 years old, n = 20). The inclusion and exclusion criteria were established based on the International Ankle Consortium Position Statement (Gribble et al., 2014). To be included in the CAI group, individuals must have answered "yes" to question 1 ("Have you ever sprained an ankle?"), along with "yes" to at least four questions related to perceived ankle instability and giving-way episodes of the Ankle Instability Instrument (AII) (Docherty et al., 2006; Gribble et al., 2014). In addition to functional instability, individuals included in the CAI group should also present mechanical instability expressed through a positive drawer test (Docherty et al., 2006; Gribble et al., 2014; van Dijk, 2002; Vries et al., 2010). Athletes were excluded from both groups if they presented surgery or fracture history in both lower limbs and other pathologies affecting balance. Participants were excluded from the CAI group if the last ankle sprain occurred in the last 3 months (Caffrey et al., 2009). In the healthy group, only athletes without previous history of the sprain (both ankles), who responded 4 or less times "yes" in the AII and who completed negatively bilaterally a drawer test were accepted (Docherty et al., 2006; Gribble et al., 2014; van Dijk, 2002; Vries et al., 2010).

The present study had the approval of the Ethics Committee from the School of Health - Polytechnic Institute of Porto, having the athletes signed the informed consent form.

Measures

Anthropometric data were evaluated with a balance – Seca® 760 (1 kg accuracy), and a stadiometer - Seca® 222 (1 mm accuracy). Dorsiflexion range of motion was assessed with a fluid-filled inclinometer with 1° increments (MIE Medical Research Ltd, Leeks, UK) (Rabin et al., 2015). The Ankle Instability Instrument was designed to classify individuals with CAI and has been shown to be a reliable and valid tool (Docherty et al., 2006; Silva et al., 2018). The values of the vertical component of ground reaction forces (Fz) were used to identify the contact period of the foot with the artificial grass and were acquired using two force plates at a sampling rate of 1000 Hz (FP4060-08 and FP4060-10 models from Bertec Corporation (USA), connected to a Bertec AM 6300 amplifier and to an analogue board, from Qualisys, Inc., Sweden) (Silva et al., 2017a). The *Qualisys motion capture* system (four cameras Oqus 1) with an acquiring frequency of 100 Hz was also used to analyse the distance travelled by a marker placed at the calcaneus. The platforms were covered by the 3rd generation artificial grass carpet consisting of polyethylene/polypropylene filaments of 40-65 mm and filled with silica and rubber (Sterzing et al., 2010). Qualisys Track Manager software, 2.7 version, was used for analysis.

Design and Procedures

Following the anthropometric assessment, weight bearing dorsiflexion range of motion was registered with an inclinometer positioned 15 cm distal to the tibial tuberosity (Rabin et al., 2015). All measurements were performed by the same researcher, who was also an experienced physiotherapist. The dorsiflexion range of motion was used only to distinguish between the two groups regarding the risk of LAS, associating the decreased dorsiflexion to a higher risk factor of LAS (Terada et al., 2013). After this, each participant performed a 10-min warm up on a cycle-ergometer with a load of 2% of body weight at 60 rpm (Silva et al., 2017a). For the functional assessment, participants were informed that they should perform 10 consecutive unipodal and medio-lateral jumps at maximum speed with the dominant limb (selected according to which leg they used for kicking a ball) (Figure 1). Participants had the opportunity to experience the task to reduce the learning effect. This functional test was adapted from the *Side Hop Test* (Caffrey et al., 2009; Docherty et al., 2005). Each participant performed one trial, with each of the four cleat models: TF, AG, HG and FG (Table 1) as fast as possible (Sterzing et al., 2010). The order of the cleat model use was randomized. A reflective marker was fixed on each model on the posterior surface of the calcaneus. As can be seen in Figure 1, each medio-lateral jump was performed between two force plates. Each test started and ended on the same force plate (Caffrey et al., 2009; Docherty et al., 2005) and was considered valid when a minimum distance of 30 cm in the medial-lateral direction was achieved (Caffrey et al., 2009; Docherty et al., 2005), otherwise players repeated the trial. All participants had a 2-min rest period between trials.

The signal from the force plates was filtered through a low-pass fourth-order *Butterworth* filter of 15 Hz frequency and normalized to the body weight (Silva et al., 2017a). The test runtime was defined as the time interval between the beginning of the test and the performance of 10 jumps. The beginning of the test was the instant where the value of Fz of the starting force plate was less than 10 N. The end of the test was defined as the moment when the Fz value exceeded 10 N (Silva et al., 2017a). A second-order *Butterworth* low-pass filter of 6 Hz frequency was applied to kinematic data (Silva et al., 2017a). The distance travelled was defined as the total distance travelled by the marker placed at the calcaneus during the test runtime. The mean velocity was defined as the ratio of the test runtime and the distance travelled. During processing and analysis of the data, the researchers were blinded considering the group assignment.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics software 21, with a significance level of 0.05. The Shapiro-Wilk test indicated that the data was normally distributed. The mean value was used as a measure of the central tendency, and the standard deviation as a measure of dispersion. Relative frequencies were also used for descriptive statistics. The repeated measures ANOVA was used for comparing the test runtime, the distance travelled and mean velocity between the four cleat models. The cleat model was considered a within-subject factor, while the group was a between-subjects factor. The Bonferroni correction was used for post-hoc analysis.

Results

No differences between groups were observed regarding age (p = 0.586), height (p = 0.594) and body mass (p = 0.430), however, decreased dorsiflexion range of motion (mean difference = 6.41°) was observed in the CAI group (p < 0.001). The CAI group reported on average 2.6 sprains and most of the athletes suffered their last sprain more than a year (35%) or two years ago (45%) (Table 2). Regarding the cleats preference (Table 3), no statistically significant differences were observed between groups (p = 0.467).

No significant interaction was observed in the test runtime (p = 0.559), distance travelled (p = 0.961) and velocity (p = 0.610) between the group and the cleat model (Table 4). Despite the CAI group revealed a tendency for higher mean velocity with all models compared to the control group, no significant differences where observed between groups (Table 4). Also, no differences between groups were observed in the runtime and distance travelled. When the different models were compared in each group, no differences were also observed for the three variables evaluated (test runtime p = 0.723; distance travelled p = 0.121; mean velocity p = 0.476) (Table 4).

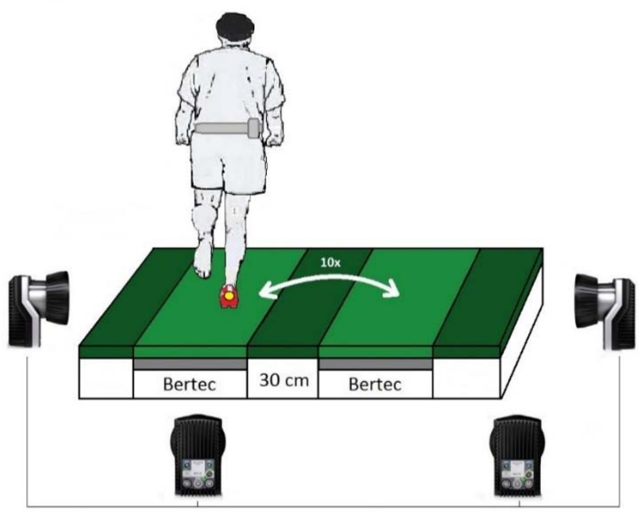

Figure 1

Functional Test

Table 1

Cleats' characteristics

	Studs/sole material	Studs Number	Size	Geometry
	Rubber studs and a compliant sole	> 55	6-7 mm	
		22	8-10 mm	Prismatic
	Plastic studs and a rigid plastic sole	14	10-12 mm	
		11	10-12 mm	

Adapted from (Silva et al., 2017b)

Table 2

Sample characterization

		Healthy group Mean ± SD	CAI group Mean ± SD	p
Age (years)		21.21 ± 3.28	20.70 ± 2.49	0.586
Body mass (kg)		69.53 ± 7.81	68.38 ± 5.12	0.594
Height (m)		1.76 ± 0.04	1.75 ± 0.06	0.430
Dorsiflexion (degrees)		41.89 ± 4.97	35.48 ± 4.11	<0.001
Number of sprains		-	2.55 ± 1.35	-
How long ago did the last sprain occur relative frequencies (%)	3-6 months	-	10.0	-
	6-12 months	-	10.0	-
	12-24 months	-	35.0	-
	> 24 months	-	45.0	-

Legend: SD - standard deviation

Table 3

Athlete's preference regarding the cleats to use on artificial grass

	Healthy group (%)	CAI group (%)	p
TF	0	0	
AG	53	35	0.467
HG	21	40	
FG	26	25	

Legend: TF – Turf; AG – Artificial grass; HG - Hard ground; FG – Firm ground

Table 4

Performance variables during the Side Hop Test in Healthy and CAI groups

		Group		Effect size	Within-group measures			Between-group measures		
Variables	Cleat model	Health Mean ± SD	CAI Mean ± SD	(CI) 95%	F	p	OP	F	p	OP
Runtime (s)	TF	7.432 ± 0.613	7.393 ± 0.644	0.062 (-0.37 – 0.45)	0.442	0.723	0.136	0.347	0.559	0.089
	AG	7.561 ± 0.596	7.282 ± 0.485	0.466 (-0.07 – 0.63)						
	HG	7.503 ± 0.693	7.451 ± 0.678	0.076 (-0.39 – 0.50)						
	FG	7.452 ± 0.676	7.384 ± 0.645	0.103 (-0.36 – 0.50)						
Distance travelled (m)	TF	15.845 ± 1.565	15.910 ± 1.279	-0.045 (-0.99 – 0.86)	1.980	0.121	0.498	0.002	0.961	0.050
	AG	16.192 ± 1,594	15.643 ± 1.315	0.376 (-0.40 – 1.50)						
	HG	16.083 ± 1.679	16.345 ± 1.623	-0.159 (-1.33 – 0.81)						
	FG	15.825 ± 1.698	15.956 ± 1.627	-0.079 (-1.21 – 0.95)						
Mean velocity (m/s)	TF	2.137 ± 0.193	2.162 ± 0.194	-0.129 (-0.15 – 0.10)	0.837	0.476	0.227	0.264	0.610	0.079
	AG	2.147 ± 0.207	2.156 ± 0.212	-0.043 (-0.15 – 0.13)						
	HG	2.150 ± 0.200	2.201 ± 0.205	-0.252 (-0.18 – 0.08)						
	FG	2.129 ± 0.198	2.169 ± 0.221	-0.191 (-0.18 – 0.10)						

Legend: SD – Standard deviation; TF – Turf; AG – Artificial grass; HG - Hard ground; FG – Firm ground; CAI – Chronic ankle instability group; CI - Confidence interval; OP – Observed power

Discussion

The choice of the footwear has been demonstrated to have impact on variables that can predispose to injury and on variables related to athletes' performance (Conenello, 2010; Silva et al., 2017b). The speed with which the athlete moves on the field has become a very important factor in modern soccer. Thus, the ideal cleat model should allow the athlete to perform all movements powering traction and stability (Hennig, 2011).

The absence of significant differences in Side Hop Test performance between different cleat models in both groups, seems to refute the hypothesis that structural differences of the models are sufficient to influence athletes' functional performance. Similar results were described when TF, AG and FG models were compared during sprints (De Clercq et al., 2014). Thus, it does not seem necessary to choose a specific cleat model to optimize performance on dry artificial grass fields. However, athletes, coaches and the medical staff should be aware of the findings of future studies evaluating the influence of the cleat models on the risk of injury especially in CAI players.

It is important to note that athletes from the present study were not familiarized with the use of TF when playing on artificial grass. This aspect would lead to worse performance with this model (Hennig, 2011; Muller et al., 2010). However, no differences were observed between this cleat model and the others. The conditions of the artificial grass used in the present study would have contributed to these results, as they differed slightly from the game/practice conditions, and may have influenced the athletes in the performance tasks (Brito et al., 2012). A dry artificial grass may have allowed similar traction between models and this could explain the similar performance values (Sterzing et al., 2009). These results may differ substantially if the study was performed on wet grass.

It would be expected that the CAI group achieved worse performance executing the Side Hop Test (Docherty et al., 2005). In this study, although it was not verified significant cleat-groups interaction, there was a tendency for better performance in the test by the CAI group. This result could be due to the fact that the original test was described with barefoot participants (Docherty et al., 2005). Its realization with cleats may have provided comfort and ankle stability, reducing possible differences between the groups with and without CAI (Rabello et al., 2014). Finally, the athletes with CAI may have benefited from neuro-motor adjustments arising from injury rehabilitation, providing similar performance values to the healthy group (Caffrey et al., 2009; Schiftan et al., 2015). The decreased dorsiflexion after rehabilitation presented in the CAI group does not appear to have influenced performance in this test. However, the dorsiflexion range of motion in the CAI group may play a key role in the study of cleat-surface interaction for the risk of injury, namely ankle sprains. Therefore, in future studies this variable must be present in sample characterization. Furthermore, future studies may benefit from having access to imaging diagnostic tools to confirm the functional impairment of athletes classified with CAI.

Although it is most common to evaluate performance during sprint tests, functional tests such as the Side Hop Test can be a very interesting option to assess performance, since they impose an unusual functional task being a major challenge specially for athletes with CAI. Lastly, it should be noted the lower observed power and effect size as well as the need of studies involving a greater sample to confirm our results.

In summary, different cleat models seem not to influence performance expressed by the side hop test runtime, distance travelled and mean velocity in athletes with and without CAI.

Perspective

Performance assessment is a key area in sport, especially in populations with an increased risk of injury. Prior to this study, it has been assumed that the Soft Ground cleat models negatively influenced sports performance on artificial grass (Muller et al., 2010; Sterzing et al., 2009; Sterzing et al., 2010). However, their use on artificial grass is strongly discouraged by manufacturers and even prohibited by some federations such as the Portuguese Football Federation. Thus, there is a need to compare different cleat models that are allowed for this field. The results of this study indicate that performance assessed through functional tests does not seem to be influenced by the cleat models on artificial grass. These findings seem to be transversal to athletes with and without CAI. These results highlight the role of performance evaluation using specific and demanding functional tests for certain clinical conditions such as CAI, pointing to the importance of evaluating only cleat models permitted on artificial grass fields. In addition, it will be important to use these results to inform the sports community to choose the cleat model mainly by considering their potential injury risk, rather than their influence on functional performance, as it does not appear to be significant.

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