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Research Paper

The Effect of Using Ordinary and Weightlifting Shoes on Oscillation of the Center of Foot Pressure in Professional Weightlifters while Performing the Squat[1]

Ali Fatahi[1], Aria Kazemi mehr[2], Razieh Yousefian Molla[3]

1. Department of Sports Biomechanics, Central Tehran branch, Islamic Azad University, Tehran, Iran. (Corresponding Author)
2. 1. Department of Sports Biomechanics, Central Tehran branch, Islamic Azad University, Tehran, Iran.
3. Department of Physical Education and Sport Science, Faculty of Physical Education and Sports Sciences, Islamic Azad university of Karaj, Karaj, Iran.

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Abstract

The main question of the present study was whether the use of ordinary shoes and weightlifting shoes is effective in changing oscillation of the center of foot pressure (COP) in professional weightlifters during the performance of squat movement. 20 professional male weightlifters used the free barbell to perform squat skill in three conditions, with barefoot, ordinary shoes as well as a particular weightlifting shoes on a foot pressure tool, with the aim of scanning the foot plantar segment and examining oscillation of the center of pressure in foot. In order to analyze the data, the map and the oscillation parameters of the plantar pressure center of each athlete in three conditions were extracted from the pressure foot device. COP path line and its ellipsoidal area were investigated. The results showed that the use of ordinary shoes and weightlifting shoes demonstrated significant effects on the two variables of path line and ellipsoidal area of COP and increases balance in weightlifters during squats significantly. The use of weightlifting shoes while performing important and fundamental squats in weightlifters, increases balance and is recommended to athletes and coaches to consider the use of these sports tools to prevent injury and improve their performance.

Keywords: Weightlifting, Shoe, COP, Squat, Biomechanics

1. Email: fattahiali81@gmail.com
2. Email: aria_kazemimehr@yahoo.com
3. Email: aziehyousefianmolla@gmail.com

Introduction

The foot is one of the main segments of the body which is in direct contact with the moving surfaces due to its position at the end of the closed kinetics chain. Regarding a biomechanical point of view, it is a functional unit for maintaining balance, transferring body weight to the ground and a lever for body locomotion (Earl & Hertel, 2001). During athletic skills, the foot has two main functions, including passive action aiming protection of the body regarding the collision forces and active function in order to transfer the internal forces produced by the muscles to the ground during various sport skills. Therefore, in order to consider the effective performance of the foot during sports activities, it is important to study the structure of the foot (Faria, Gabriel, Abrantes, Brás, & Moreira, 2010). Shoes, as the only mediator between the body and the ground, play a significant role in foot wellness and health and protecting it against the reaction forces of the ground (Doi et al., 2010). Shoes affect the distribution of the foot pressure and the amount of the applied forces, as it acts as an intermediary between the sole and the ground. Each sport has its own shoes, and in the meantime, weightlifting is no exception to this. Like the other sports, in addition to the need for proper physical fitness and strength, it also depends on appropriate tools and equipment such as shoes. Among the powerful skills of the weightlifting, squat is considered as a unique skill that is widely used. It is unique in comparison with other skills due to the involvement of about 65% of the total skeletal muscles of the body and in terms of the degree of its inclusion (Legg, Glaister, Cleather, & Goodwin, 2017). Therefore, it is very important to pay attention to its technical and instrumental points, including appropriate shoes.

In the past, some researchers have focused on the effect of shoes and insoles on oscillations and the distribution of the foot's center of pressure (COP) while considering on the effect of these tools on various abnormalities (Abbasi, Alizadeh, Daneshmandi, & Barati, 2015; Meng, Yuan, & Kang, 2007). Some researchers studied the effect of shoes and insoles and their types on sports skills (Molloy et al., 2009; Wegener, Burns, Penkala, & Sc, 2008). On the other hand, there are some studies which examined the effect of shoes and their types on the kinetics and kinematics of the lower limb during the performance of squat skill or focused on the effect of shoes on Squat skill independently (Legg et al., 2017; Southwell, Petersen, Beach, & Graham, 2016). Along the way, Cohen et al. (2017) found that the use of shoes created a better balance when performing squat skill relative to the barefoot position (Cohen, Lee, & Buchman-Pearle, 2017), while Forton Bach et al. (2010) and Hawkes et al. (2015) presented that shoes do not have a significant effect on the kinetics and kinematics of the lower limbs (Fortenbaugh, Sato, & Hitt, 2010; Hughes & Prescott, 2015).

Due to the existing contradictions, since there is no direct research on the impact and comparison of weightlifting and ordinary shoes on how to distribute the

pressure of the weightlifters' feet during the squat movement, the present study was conducted to investigate the effect of using ordinary shoes and weightlifting, based on the selected parameters of foot pressure distribution and balance performance of elite weightlifting athletes, while performing squats, the results of this type of shoes in performing the important and high-risk skill and also improve the activities of this. The discipline and performance of athletes and their coaches should help to determine the effect of using standard shoes in weightlifting squats. Therefore, the main question of the present study is whether the use of ordinary shoes and weightlifting shoes is effective in oscillation of the center of foot pressure (COP) in professional weightlifters during the performance of squat skill?

Methods

The present study was a quasi-experimental study. According to the G-power statistical software, the statistical sample of this research includes 20 professional male weightlifters (with demographic characteristics: age: 21 ± 77.4 years, weight: 74 ±75.6 kg, height: 169± 45.4 cm, sole length: 3.45 ± 2.25 cm, sports history: 5.2±4.1 years), was considered by available sampling method. The subjects of this study followed the usual weightlifting exercises for at least 5 days a week. Exclusion criteria were considered including the subject's incidence of inner ear disease, balance disorders, history of any fracture or lower and upper limb surgery, all of which were assessed through a medical health questionnaire by an expert, was evaluated. Besides, all subjects were informed of all stages of the test procedures and signed a written consent to participate in this study.

In order to familiarize the athletes with the laboratory environment and the steps of the test, before the evaluation, squat movement was practiced several times on the device. After regular and specific weightlifting warm-ups, including stretching and joint exercises, under the supervision of an expert instructor in this field, athletes use the free barbell to perform squat in three conditions, once while being barefoot, second with ordinary shoes and on the third condition with a particular weightlifting shoe (Nike®). They performed the task on a foot pressure tool (PT-Scan4452F100 made by Payamavaran Ferdowsi Company), with the aim of scanning the sole of the foot in order to investigate the oscillations of the center of pressure. Each of the evaluation steps with and without shoes was performed with 3 repetitions and 5-minute breaks, and among them, the best squat movement for each person, under the supervision and selection of an expert bodybuilding instructor present in the laboratory, was selected.

In order to analyze the data, the map and the oscillation numbers of the sole pressure center of each athlete in three positions were extracted from the pressure foot device. Then, the location and displacement of COP and its peripheral oval area were investigated.

SPSS software model 21 was used for statistical analysis of outputs. For this purpose, descriptive statistics including mean and standard deviation were used. Then, the normality of data distribution was evaluated using Shapirovilk test, and finally, Repeated Measures test and Bonferroni post hoc test were used for inferential analysis to evaluate the effect of different shoes on the mentioned variables. All steps of analytical and statistical methods were performed at a significance level of 0.05.

Results

The results of descriptive statistics related to the research variables can be seen in Table 2 and Figure 1. As can be seen from the results of this table, the two variables of displacement rate and circumferential oval area of COP, in barefoot position, has the highest average.

Table 1- Mean Values and Standard Deviation of the Variables Tested In The Research

variable	COP path line (mm)	Ellipsoidal area of COP (mm^2)
	Mean ± SD	
Bare foot	479.03 ± 32.48	2000.71 ± 122.24
Ordinary shoes	322.37 ± 29.60	1316.57 ± 60.06
Weightlifting shoes	268.92 ± 32.47	884.71 ± 72.10

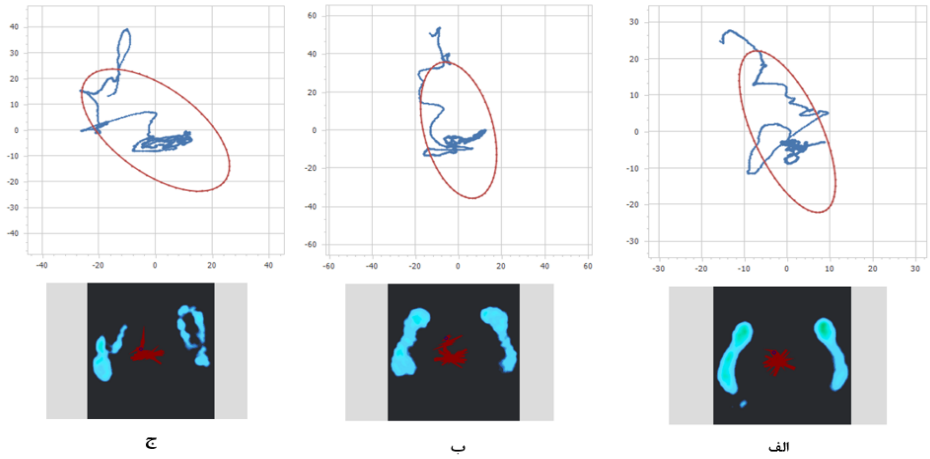

Figure 1-Moving Rate (Bottom Photos) and COP Circumferential Oval Area (top Photos) in (a) Barefoot, (b) Ordinary Shoes, (c) Weightlifting Shoes While Performing Squat Skill on the Foot Pressure Device

The results of the Shapiro-Wilk test showed normal data distribution. Also, the results of repeated measures test showed that evaluations in three positions of bare feet, with ordinary shoes and weightlifting shoes, demonstrated significant effects on the two variables of displacement and peripheral oval area of COP (Table 3) ($p \leq 0.05$).

Table 2- Results of Repeated Measures Test Obtained from Changes in Research Variables in Three Situations

Source	Sum of squares	df	Mean of squares	F	Sig.
COP path line	47692.92	2	23848.46	77.26	0.00*
Error	117287.56	38	3086.51		
Ellipsoidal area of COP	1.26	2	6333249.96	61.39	0.00*
Error	3919930.92	38	103156.07		

* P<0.05

As can be seen in Table 3, the results of Bonferroni post hoc test also showed that the mean of the variables was significant in pairs in all barefoot positions, with ordinary shoes and weightlifting shoes ($p \leq 0.05$).

Table 3- Results of Bonferroni Post Hoc Test to Compare the Difference Between the Means of Research Variables in Three Situations

Variables	situation	situation	Mean differences	Standard error	Sig.
COP Path Line (mm)	Weight lifting shoes	Ordinary shoes	-53.45	16.49	0.01*
		Bare foot	-210.11	20.70	0.01*
	Ordinary shoes	Weightlifting shoes	53.45	16.49	0.01*
		Bare foot	-156.65	15.01	0.01*
	Bare foot	Weightlifting shoes	210.11	20.70	0.01*
		Ordinary shoes	156.65	15.01	0.01*
Ellipsoidal Area of COP (mm^2)	Weight lifting shoes	Ordinary shoes	-431.86	73.41	0.01*
		Bare foot	-1115.99	128.37	0.01*
	Ordinary shoes	Weightlifting shoes	431.86	73.41	0.01*
		Bare foot	-684.13	28.95	0.01*
	Bare foot	Weightlifting shoes	1115.99	128.37	0.01*
		Ordinary shoes	684.13	28.95	0.01*

* P<0.05

Discussion

The aim of the present study was to investigate the use of ordinary shoes and weightlifting shoes on oscillation of the COP of professional weightlifters during the performance of squat skill. The results showed that the use of ordinary shoes and weightlifting shoes reveals significant effects on the two variables of displacement rate and area of COP circumferential oval and increases balance in weightlifters during squats.

Sport shoes are used in many sports to provide comfort and protect the body against excessive force and improve skill performance. For example, reduction of the impacts from repeated foot collisions with the ground and excessive pronation in the metatarsal joint is a vital element in using shoes to prevent injury in many sports (Hughes & Prescott, 2015). Also, proper sports shoes are needed to stabilize the foot against impact-induced inversion damage in many sporting events, and in addition, in endurance sports, it also reduces energy consumption (Hertel, Gay, & Denegar, 2002; Hertel, Miller, & Denegar, 2000).

Despite the widespread popularity of scientific research on sports shoe-related topics, relatively little research has been published on comparison of the weightlifting shoes with other shoes (Hreljac, Marshall, & Hume, 2000). As stated earlier, the main purpose of this study was to investigate the effect of using ordinary weightlifting shoes on selected biomechanical parameters of COP pressure distribution in elite weightlifters when performing squats. Stewart et al. (2007)) in a similar study, examined the distribution of intra-shoe pressure in unstable shoes and sneakers, but in contradiction with the findings of the present study, there was a significant difference in the amount of total contact surface of the foot, and consequently more balance between unstable shoes and shoes with flat soles were not reported (Stewart, Gibson, & Thomson, 2007). Meng et al. (2007) also compared the pressure distribution between the soles of the shoes and the soles of the feet and reported that while walking barefoot and running sneakers, the highest pressure was observed in the heel area and then in the forefoot area, the middle leg experiences the least amount of pressure. This finding indicates that the pressure distribution is the same in barefoot and was not in agreement with the findings of the present study. Perhaps one of the reasons for the inconsistency of these two studies with our study is the difference in the type of sport, the subject and also the type of shoe selection. Molley et al. (2009) also showed in a study that at the base position, the amount of ankle dorsiflexion increased compared to when shoes were used, resulting in ankle torsion (ratio of eversion to inversion) and amplitude as well as foot adaptation is limited (Molloy et al., 2009).

Tsai et al. (2006), and Pauk et al. (2010) in a study similar to the present study, examined and compared the friction and reaction force of the ground, using different shoes with different stiffness, and found that the subjects began to walk

at their own speed after wearing the shoes. They walked and the passive force at the peak of friction did not differ significantly between the two conditions (Pauk, Daunoraviciene, Ihnatouski, Griskevicius, & Raso, 2010; Tsai, Yu, Mercer, & Gross, 2006) .

The purpose of the present research was based on the study of the balance and oscillations of the pressure center following the use of two types of casual and sports shoes. Robbins et al. (1994) conducted a similar study and concluded that a stable balance during transport superior athletic performance and prevention of fall injuries are necessary because sneakers increase their athletic performance and safety by increasing the balance of athletes (Robbins, Waked, Allard, McClaran, & Krouglicof, 1997) . Regarding squat skill, Cohen et al. (2017) examined the effects of shoes and foot-wear on squat skill, in agreement with the present study, expressed that use of shoes provides better balance while lifting weights (Cohen et al., 2017), perhaps, according to a study by Hayley et al. (2016) (Legg et al., 2017), is to provide more flexion in the knees and thighs while squat is performed with weightlifting shoes (Meng et al., 2007). Also, due to the fact that increasing the balance of the body is provided more through the inner area of the foot than the outside, and studies such as Southwell et al. (2016) have shown that the use of different shoes and foot-wears redistributes forces and loads. It is more possible to walk in the inner part than in the outer part, as a result of increasing the balance following the use of different shoes, especially weightlifting shoes, can be justified (Southwell et al., 2016).

Conclusion

The use of weightlifting shoes while performing important and high-risk squats in weightlifters, increases balance and is recommended to athletes and coaches to consider the use of these sports tools to prevent injury and improve their performance.

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