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ORIGINAL ARTICLE

THE EVALUATION OF GROUND REACTION FORCES DURING TWO DIFFERENT SOCCER THROW-IN TECHNIQUES: A PRELIMINARY STUDY

Abstract

The purpose of this study was to examine the differences in Ground Reaction Forces (GRF) between standing and running soccer throw-in. Six male amateur soccer players volunteered participated in the current study. All data are expressed as mean±SD. The longer distance was observed in the running throw-in than the standing throw-in. The standing throw-in showed higher values at Vertical (Fz) GRF during back swing, forward swing and release phases. However, that of the running throw-in during follow through phase was higher than that of the standing throw-in. As a result, the longer throwing distance in the running throw-in can be explained that the players spend shorter time in all phases at running throw-in than they did in the standing throw-in. This might causes efficient energy transfer from proximal to distal segment during the running throw-in.

Keywords: Standing throw-in, running throw-in, kinematic, force plate

INTRODUCTION

The use of throw-in is becoming more important stationary ball attacking strategy in the game of soccer (Chang, 1979; Kollath and Schwirtz, 1988; Carnys and Lees, 2007). There are two types of official throw-in techniques used mostly for attacking strategy. The first, and most widely used, is the standing throw-in (ST) and the other type is the running throw-in (RT). Both throwing techniques requires contributions from and interaction between all limb segments and the throwing action occurs proximal to distal segments (Cerrah, Onarici Gungor, and Yılmaz, 2011). Most previous investigations have concentrated on the throwing arm and upper body parts, yet poor mechanics at the arm and upper body may originate in the lower extremities. The legal soccer throwing motion is performed while the ball must come from behind the head forward with both hand, the both feet must maintain contact with the ground until release. For this reason, the ground contact during both throwing techniques must have unique contribution on the throwing performance. Therefore, the aim of this study was to examine the differences between Ground Reaction Forces (GRF) of standing and running soccer throw-ins.

METHODS

Subjects

Six male amateur soccer players volunteered to participate in the current study. Their club levels and descriptive statistics are summarized in Table 1. None of the subjects had any previous injury of their upper limbs.

Table 1: Descriptive statistics of players

Amateur Soccer Players	Age (years)	Athletic History (years)	Height (cm)	Body Mass (kg)	Dominant Arm	
n	mean±SD	mean±SD	mean±SD	mean±SD	right	left
6	21.33±1.34	9.83±2.17	180.50±5.50	72.83±6.23	6	-

Data Collection

While standing throw-in was performed with one step, running throw in was performed with three steps where the final step was corresponding to the force plate. Both throw in techniques performed using a full size (number 5) soccer ball and ball pressures were

adjusted to 11 psi. Subjects were asked to throw the ball as far and fast as possible. The players performed 5 trials for each throw-in technique and the throwing distance was measured.

Instruments

The anteroposterior (Fx), mediolateral (Fy) and vertical (Fz) components of the ground reaction forces were measured at a sampling frequency of 1000 Hz using a Kistler force plate (Kistler, 9281EA) and normalized according to body weight. The force data were recorded from initial heel contact until the time just toes leave the force plate. A video camera (25fps) (Canon HG 21) was placed perpendicular to the lateral side of the player to identify back swing (BS), forward swing (FS), Release (R) and follow through (FT) phases of both throw-in techniques.

Data Analysis

The ground reaction forces were measured at a sampling frequency of 1000 Hz using a Kistler force plate (Kistler, 9281EA) and normalized according to body weight. The trials having the best throwing distance were chosen for further analyses. Data was analyzed using “Bioware software. All data are expressed as mean \pm SD.

RESULTS

The achieved distance in the standing and the running throw-in were 19.53 ± 1.90 m and 21.42 ± 1.15 m respectively. Some of the segmental movements and the occurrence time of them were identified during both throw-in techniques. According to this identification, second foot contact (0,28msec), max. trunk extension (0,39msec), max elbow flexion (0,51msec), release (0,62msec) at standing throw-in (figure 1) and max. trunk extension (0,07msec), max elbow flexion (0,15msec), release (0,25msec) at running throw-in (figure 2) have calculated right after heel contact to the force plate

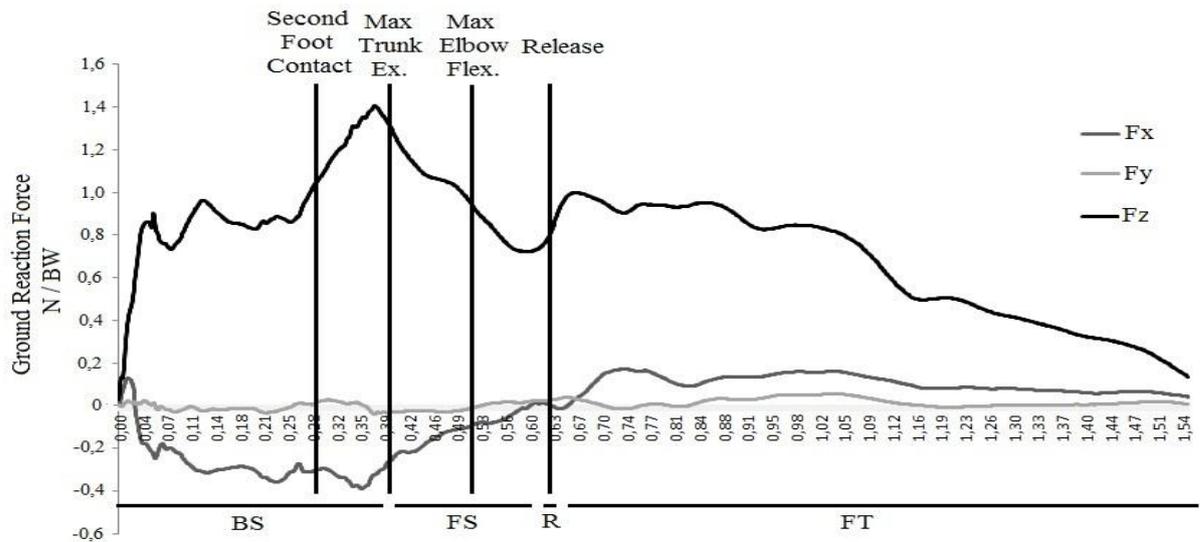


Figure 1: Maximum ground reaction forces (expressed as a percentage of body weight, BW) during running throw-in in the anteroposterior, mediolateral, and vertical axis.

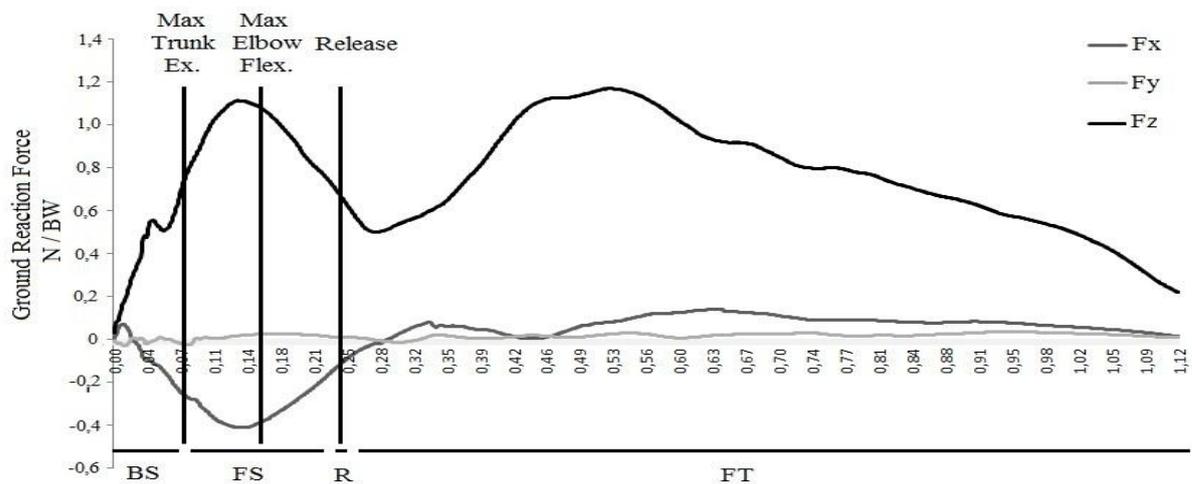


Figure 2: Maximum ground reaction forces (expressed as a percentage of body weight, BW) during running throw-in in the anteroposterior, mediolateral, and vertical axis.

The average forces according to phases were Fx (BS:-0,19955N; FS:-0,18397N; R: 0,15497N; FT: 0,15112N), Fy (BS: -0,0070N; FS: 0,00578N; R: -0,02268N; FT: 0,01800N) and Fz (BS: 0,80415N; FS: 1,07365N; R: 0,61935; FT: 0,71212N) at standing throw-in and Fx (BS: -0,01699N; FS: -0,31994N; R: -0,09096N; FT: 0,08997N), Fy (BS: -0,01699N; FS: 0,01457N; R: 0,01160N; FT: 0,01744N) and Fz (BS: 0,36874N; FS: 0,89627N; R: 0,57351N; FT: 0,82169) running throw-in (Figure 3).

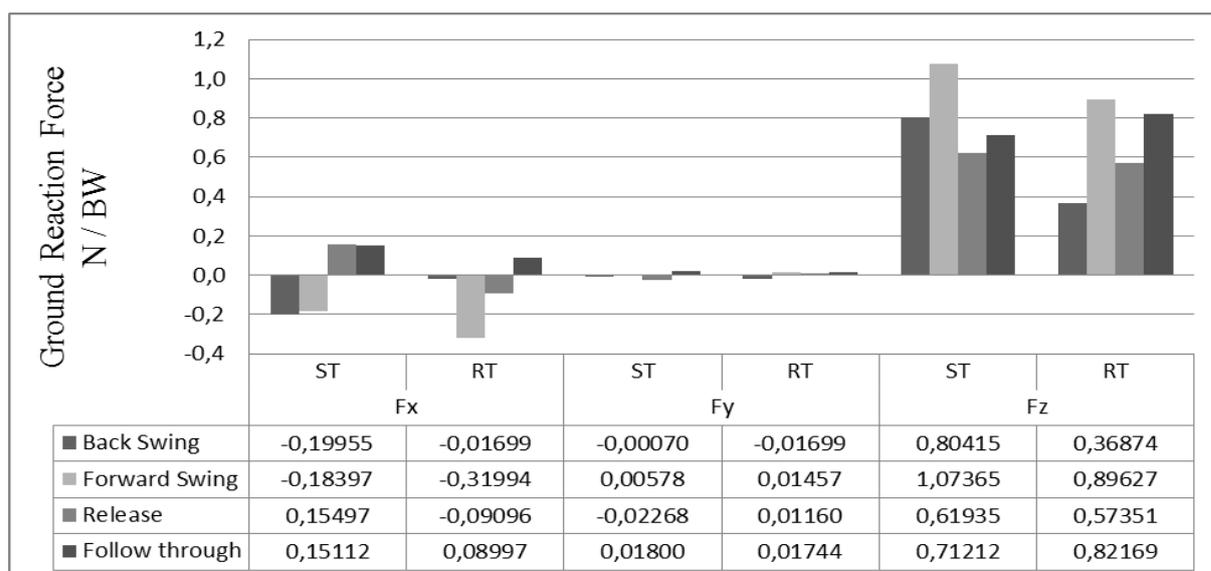


Figure 3: Average ground reaction forces (expressed as a percentage of body weight, BW) according to phases during Standing and Running throw-in in the vertical, anteroposterior, and mediolateral axis.

DISCUSSION

The result of throwing distance comparable with the literature (Lees, Kemp, and Moura, 2005; Linthorne and Everett, 2006) and the higher distance have been achieved in running throw-in ($21,42 \pm 1,15\text{m}$) than standing throw-in ($19,53 \pm 1,90\text{m}$). Previous researches agreed that the velocity of the hand before release has positive correlation with the ball velocity and distance (Levendusky, Clinger, Miller and Armstrong, 1985; Messier and Brody, 1986; Kerwin and Bray, 2004). According to kinematic analyses of soccer throw-in techniques, it is concluded that both techniques movements have proximal to distal sequential segment motion. During the back swing phase, the trunk is extended and the knee is flexed and the upper body (chest and abdominal muscles) stretched, after the ball move forwards the chest and abdominal muscles are shorten and the trunk moves forward as fast as possible. This situation called as stretch-shortening cycle in dynamic movements (Kollath and Schwartz, 1988; Cerrah, Onarici Gungor, Soylu, Ertan, Lees, and Bayrak, 2011). Cerrah et al. (2011) analyzed correlation between isokinetic strength parameters of trunk, shoulder and elbow with running and standing throw-in. Having not high number of correlation between strength parameters with running throw-in they concluded that the running throw-in is more related to motion dependent moment of the segments occurred as a result of neuromuscular coordination and energy transfer from running phase to throwing phase and do not require more strength (Cerrah et al. 2011). Therefore this stretch shortening action leads to an increase in the pre-loading of muscle and as a result, more work is done with using less

strength in running throw-in than the standing throw-in. To date, even though there are several studies of kinetic and kinematic variables of throwing arm related to different throwing techniques (Kerwin and Bray, 2004; Lees et al., 2005; Linthorne and Everett, 2006), there is only a research (Levendusky et al., 1985) about the ground reaction forces of these techniques. The result of the current study shows that, even though the force data show similar force values, the standing throw in has distinguishable higher values at Fz in BS, FS and R phases. However, that of the running throw-in FT phase was higher than the standing throw-in. Furthermore, Fx, Fy and Fz forces interestingly get almost “0” at the time of release which is similar with Levendusky et al. (1985). They indicated this situation that, while the lead foot is placed to stop the moving body, it translates occurred momentum to the upper body parts. After the upper body parts are rotating by this momentum with a greater velocity, the body is raised up and away from the ground.

Ground-reaction forces from the soccer players are highly repeatable within trials of the same technique and the subject; however; the characteristic patterns of both techniques are differ in the standing and the running throw-in. The results show that players have performed BS and FS phases in shorter time at running throw-in than the standing throw-in. Having longer throwing distance in the running throw-in may be explained that the spending shorter time in all phases may cause faster energy transfer and segmental movement during proximal to distal. The force data shows that Fy forces are not determinant factor for soccer throw-in performance. On the other hand, Fx forces are important especially before release for soccer throw-in. Even though the peak Fx forces are similar before release in both throw-in techniques, Fz forces increase when the spent time increases before ball release. It may be explained that spending more time on the ground before release causes decreasing velocity of the player in horizontal direction and increases Fz forces.

As a result, both techniques shows different characteristic of ground contact. Furthermore in order to perform long distance throw, the running throw-in could be more effective. It can be also suggested for coaches and players that, it is important to improve approaching velocity and fast phase transfer as well as improving muscular strength of upper extremity (trunk, shoulder and elbow), technique and release condition.

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