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

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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 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.

KEY WORDS: standing throw-in, running throw-in, kinematic, force plate.

INTRODUCTION: The use of the throw-in is becoming a more important stationary ball attacking strategy in the game of soccer (Chang, 1979; Kollath & Schwirtz, 1988; Carnys & 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 require contributions from, and interaction between, all limb segments and the throwing action occurs proximal to distal (Cerrah, Onarici Gungor, & 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 hands, and 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 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: 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	-

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 were 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 as fast as possible. The players performed 5 trials for each throw-in technique and the throwing distance was measured. 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 were normalized according to body weight. The force data were recorded from initial heel contact until the time the toes left 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. The trials having the best throwing distance were chosen for further analyses. All data were expressed as mean ±SD.

RESULTS: The achieved distance in the standing and the running throw-ins were 19.53±1.90m and 21.42±1.15m 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 occurred right after heel contact with the force plate.

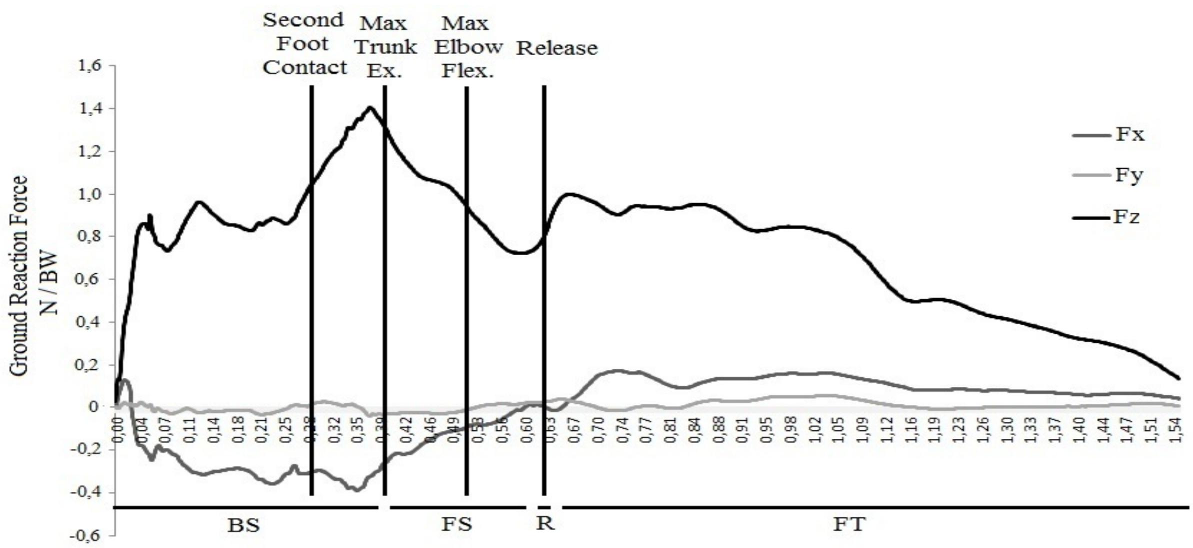


Figure 1: Maximum ground reaction forces (expressed as a percentage of body weight, BW) during running throw-in in the anteroposterior, mediolateral, and vertical axis.

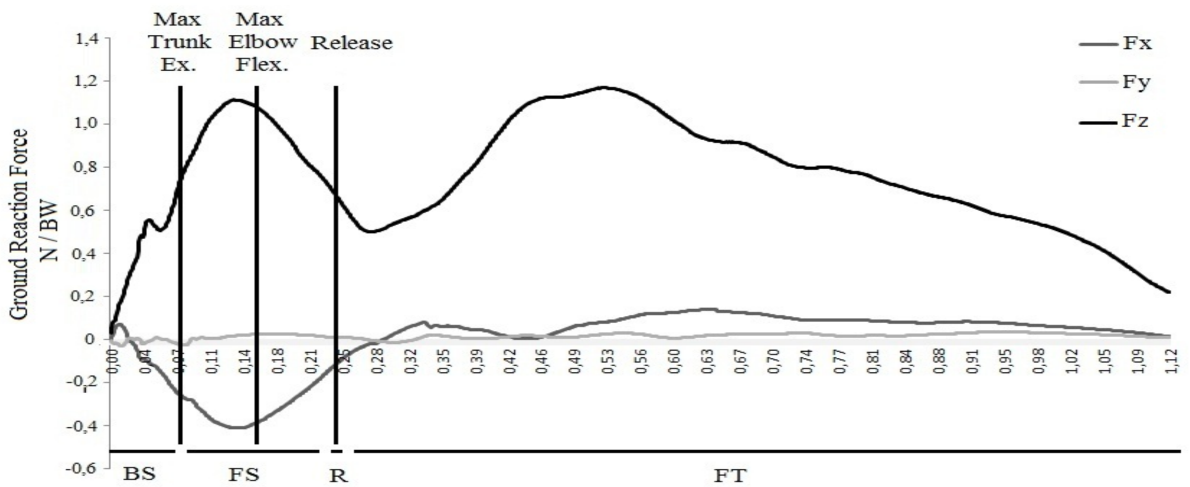
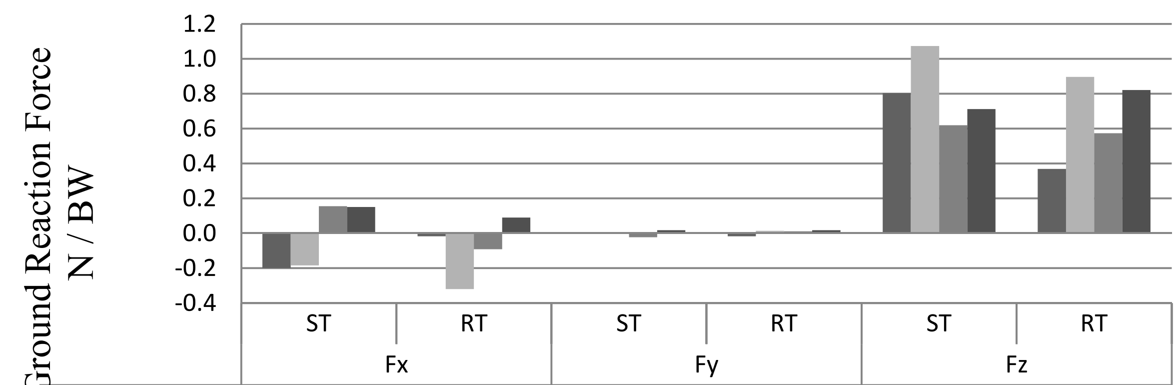


Figure 2: Maximum ground reaction forces (expressed as a percentage of body weight, BW) during running throw-in in the anteroposterior, mediolateral, and vertical axis.

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).



	ST	RT	ST	RT	ST	RT
	Fx		Fy		Fz	
Back Swing	-0.19955	-0.01699	-0.00070	-0.01699	0.80415	0.36874
Forward Swing	-0.18397	-0.31994	0.00578	0.01457	1.07365	0.89627
Release	0.15497	-0.09096	-0.02268	0.01160	0.61935	0.57351
Follow through	0.15112	0.08997	0.01800	0.01744	0.71212	0.82169

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 was comparable with the literature (Lees, Kemp, & Moura, 2005; Linthorne & Everett, 2006) and the greater distance was achieved in running throw-in (21.42±1,15m) than standing throw-in (19.53±1,90m). Previous researchers have agreed that the velocity of the hand before release has a positive correlation with the ball velocity and distance (Levendusky, Clinger, Miller & Armstrong, 1985; Messier & Brody, 1986; Kerwin & 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 & Schwirtz, 1988; Cerrah, Onarici Gungor, Soylu, Ertan, Lees, & 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 & Bray, 2004; Lees et al. 2005; Linthorne & 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.

CONCLUSION: 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 different in the standing and running throw-ins. The results show that players have performed BS and FS phases in a shorter time during the running throw-in than the standing throw-in. Having longer throwing distance in the running throw-in may be explained by spending a shorter time in all phases which may cause faster energy transfer and segmental movement. The force data shows that Fy forces are not determining factors 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 the horizontal direction and increases Fz forces.

As a result, both techniques shows different characteristics during ground contact. Furthermore, in order to perform longer distance throw ins, the running throw-in could be more effective. It can also be suggested to coaches and players that, it is important to improve approach 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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