BALL VELOCITY AND KINETICS OF THE SUPPORTING FOOT DURING TWO SOCCER KICKS, PERFORMED BY FEMALE SOCCER PLAYERS

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INTRODUCTION: The purpose of this study was to examine and compare the differences in the GRFs on the supporting foot, ball velocity, and the time of supporting foot contact (heel-strike to toe-off), in the inside soccer kick and instep soccer kick used by female soccer players.

In the game of soccer the main objectives are to have possession of the ball, pass it between players, and score a goal. When playing the game of soccer the player has to be able to kick the ball in the direction she/he wants the ball to go, with the desired velocity, and distance. One aspect that affects the direction, velocity, and distance of the soccer ball is the placement of the supporting foot. The knowledge of the ground reaction forces (GRFs) acting on the supporting foot can be used to help players develop the correct technique, and coaches as well as athletic trainers develop a proper training program that physically prepares the players for the game of soccer and prevents unnecessary injuries.

Grabiner (1993) reported that both vertical impact peak values and loading rate are likely to be related to the shock wave transmitted through the body at foot strike and may be sources of impact-related injuries. It is also likely that anteroposterior and/or mediolateral shear forces can influence injury. The ability to control the body movement along with the landing technique are factors that have been shown to affect impact forces. According to Lees (1981) any attempt to reduce force levels must be made by altering the structure of the motor program that is controlling the movement. Saggini, Calligaris, Montanari, Tjourroudis, and Vecchiet (1993) examined the GRFs during running and normal foot strike in highly skilled professional soccer players. Their findings revealed that during normal strike an impact phase was characterized by high forces between 126 $\pm$ 4% and 148 $\pm$ 3% of BW. The researchers concluded that during the stance phase the GRFs are composed of horizontal and vertical forces. When analyzing the instep soccer kick in 10 Italian professional male soccer players, Rodano and Tavana (1993) reported an average vertical GRFs as high as 2.69 times BW and 2.09 times BW at ball contact and the ball velocity ranging between 22.3 and 30 m $\bullet$ sec^{-1}. Rodano, Cova, and Vigano (1993) measured GRFs in 50 professional soccer players to determine the load on the supporting foot during a kicking motion. Their results showed peak vertical GRFs of 1.93 to 2.36 times BW and the anteroposterior along with the mediolateral peak GRFs being 0.88 to 0.55 times BW.

METHODS AND PROCEDURES: The subjects volunteering for this study were eleven healthy female soccer players from the women's soccer club team at Indiana State University. The kinetic variables in this study were measured with an Ariel Performance Analysis System (APAS) using a Kistler piezoelectric model 7281 force platform. The subjects perfomed six maximal effort inside soccer kicks and six maximal effort instep soccer kicks with a two step approach. A VHS Panasonic AG-190, Piezo Auto-focus video camera was used to record the trials

from the side view of the subjects. The electronic shutter was set at 1/500 s to reduce data point blur, the video camera collected at a rate of 30 images per second and a SVHS Panasonic AG-7350 VCR separated the A/B fields to provide video image information at 60 fields/sec. Sixteen data points were placed on the subjects, one data point on the middle of the ball, and one reference data point. Prior to recording the kicking trials a calibration cube was placed on the force platform and recorded for a period of 5 seconds. The APAS was used to calculate peak vertical GRFs during heel-strike, and toe-off, peak anteroposterior GRFs, peak mediolateral GRFs, and time of the supporting foot contact (heel-strike to toe-off). A 2 x 6 (Kicking-style x Trial) Analysis of Variance (ANOVA) with repeated measures on both factors was used to analyze the data information. Univariate ANOVAs were performed for each of the six kicking variables to identify significant differences at the .05 level.

RESULTS AND DISCUSSION: Six trials for each kicking style were evaluated. The mean values for the peak vertical GRFs during heel-strike were 203% BW or 1238.6 ± 381.1 N for the inside kick and 222% BW or 1340.9 ± 345.1 N for the instep kick. Results revealed that there were significant differences in GRFs during heel-strike for the kicking style-factor (p=.049) and the trial factor (p=.046). However, a Scheffé post hoc analysis test revealed no significant differences in the peak vertical GRFs during heel-strike for the kicking-style factor or the trial factors. No significant differences were found to the kicking-style by trial interaction factor.
The mean values for the peak vertical GRFs during toe-off were 163% BW or 984.6 ± 470.4 N for the inside kick and 181% BW or 1098.0 ± 608.0 N for the instep kick. Results revealed that there were no significant differences in GRFs during toe-off for the kicking-style factor (p=.241), the trial factor (p=.090), or the kicking-style by trial interaction factor (p=.963) (See Figure 1).

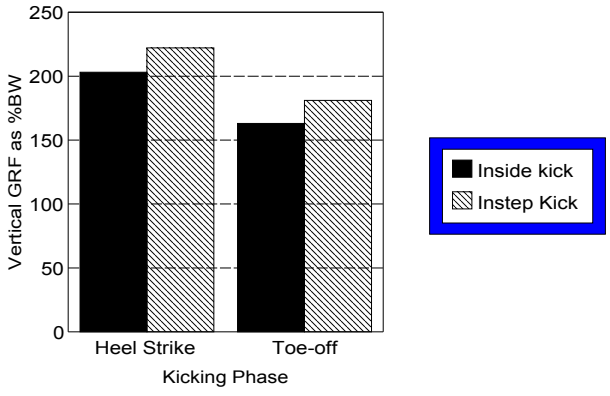

Figure 1 Vertical GRF during soccer kicking

The mean values for the peak anteroposterior GRFs were 50% BW or 304.1 ± 160.4 N for the inside kick and 58% BW or 354.6 ± 154.8 N for the instep kick. Results revealed that significant differences existed in peak anteroposterior GRFs for the kicking-style factor (p=.019), however no significant differences were found for the trial factor (p=.159) or the kicking-style by trial interaction factor (p=.737). This difference was possibly due to quicker and more forceful movement in the instep kicking motion (See Figure 2).
The mean values for the peak mediolateral GRFs were 25% BW or 152.4 ± 82.5N for the inside kick and 27% BW or 167.7 ± 130.4 N for the instep kick. Results revealed that no significant differences existed in peak mediolateral GRFs for the kicking-style factor (p=.537), the trial factor (p=.460), or the kicking-style by trial interaction factor (p=.955) (See Figure 2).

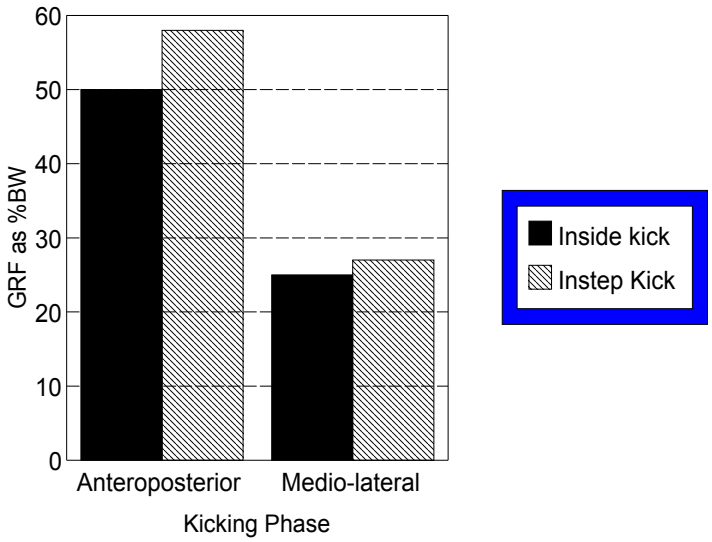

Figure 2 Anteroposterior and Mediolateral GRF during kicking

The mean values for the time of the supporting foot contact (heel-strike to toe-off) were .353 ± .09 s for the inside kick and .330 ± .12 s for the instep kick. Results revealed that no significant differences in the time of supporting foot contact for the kicking-style factor (p=.260), the trial factor (p=.128), or the kicking-style by trial interaction factor (p=.141).
The mean values for the ball velocities were 14.6 ± 2.4 m • sec^{-1} for the inside kick and 14.4 ± 2.8 m • sec^{-1} for the instep kick. Results revealed that no significant differences existed in ball velocity for the kicking-style factor (p=.664), the trial factor (p=.357, or the kicking-style by trial interaction factor (p=.976).

CONCLUSIONS: The vertical GRFs exhibited by female soccer players while using an inside and instep kick were similar to those reported by Saggini, R.,

Calligaris, A., Montanari, G., Tjouroudis, N., & Vecchiet, L., (1993), Rodano, R., & Tavana, R., (1993), and Rodano, R., Cova, P., & Vigano, V., (1993). These elevated forces observed while kicking may lead to injury from excess force or stress in the musculo-skeletal system over and above what is tolerated by the biological structures. The knowledge of the forces applied on the body during a game of soccer can help develop structural strength and flexibility which should be a part of injury rehabilitation and training programs. The knowledge of the GRFs acting on the body during a soccer kick may have implications for a soccer shoe design.

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