KINEMATIC ANALYSIS OF THE INSTEP KICK IN SOCCER PLAYERS

Dharmesh K*

*Research Scholar, National College, Dept. Phy. Edu., Tiruchirappalli, (T.N)-INDIA.
E.Mail: justusgym@gmail.com

Abstract:

The main aim of this study was to understand which kinematic variables significantly contributed to the efficiency of the instep kick motion in soccer. The study sample comprised 17 male athletes (age: 21 ± 0.6 yrs; body mass: 53.7 ± 7.20 kg; body height: 166.7 ± 6.6 cm) from local football club. Each participant performed three kicks with maximum strength that were video recorded with a camera (Sony) positioned perpendicular to the plane of the kick. Data were collected by analyzing the video recordings of each kick. Using multiple regression analysis, we determined the correlations between the prediction variables and the selected criteria (speed of the ball; $p = 0.01$). On the basis of the regression coefficients, it was concluded that two variables significantly contributed to the speed of the ball: speed of the foot of the kicking leg at the time of contact with the ball ($p = 0.01$) and the distance between the angle support leg and center of the ball ("foot posterior displacement") ($p = 0.01$). In order to achieve the best possible technical performance and, therefore, a higher speed of the ball, soccer players must pay attention to two important elements during training. First, it is necessary to position the support leg as close to the ball as possible and, second, maximize the force used in the initial phases of the kick to achieve a high speed of the kicking foot.

Keywords: Knee Angle, Biomechanics, Velocity, Foot, Support Leg & Kicking Technique.

Introduction:

Variations of the instep kick are often used in soccer, such as when passing the ball at medium and long distances, when shooting at the goal, and when performing penalty kicks (Kellis and Katis, 2007). The biomechanics of kicking in soccer is particularly important for guiding and monitoring the training process. Studies in the biomechanics of instep kicking have focused on numerous variables in different populations, but all seek to establish optimal variables, or variables that are most predictive of success, which is most typically defined by the resulting ball velocity (Ismail et al., 2010).

The instep soccer place kick is one of the most analyzed kicking actions in soccer (Dorge et al., 2002). Considering its complexity, application in the game, multiple advantages, and the desire for the best possible technical performance, the instep kick is the subject of much research that has involved all levels of players, from youth athletes to experienced professionals (Ismail et al., 2010; Barfield et al., 2002; Shan and Westwrhoff, 2005; Reilly, 2003; Kellis et al., 2004). Biomechanical techniques are important tools for many sport disciplines, but, in soccer, they are particularly useful for defining the characteristics of skills, improving mechanical effectiveness in execution, and identifying factors that influence successful performance. Knowledge and understanding of biomechanics can enhance learning and performance of sport-specific skills (Ismail et al., 2010; Amiri-Khorasani et al., 2010). Specifically, systems for the kinematic analysis of human movement provide precise measurement of values and parameters of athletes' movements during performance of any sport technique. Understanding of the biomechanics of kicking in soccer is important for monitoring and correcting performance during the training process (Meamarbashi and Hossaini, 2010). The speed of the ball in an instep kick depends on several factors, including speed of the foot of the kicking leg before contact with the ball, body posture at the moment of kicking the ball, length of the run up to the ball and its angle (Barfield et al., 2002; Stankovic et al., 2004; Meamarbashi and Hossaini, 2010; Dorge et al., 2002).

Very few studies of the instep kick have been conducted on soccer players. This is the reason for choosing this movement for our analysis. The aim of this study was to establish which kinematic variables significantly increase the speed of the ball during the instep kick. The information gained through this research will contribute to developing a more efficient movement for the instep kick in soccer. Finally, our data will encourage a faster and more efficient training process for the instep kick for youth soccer players, which will lead to an efficient application of the technique in more complex situations.

Material and Methods:

Participants:

The study sample comprised 17 male soccer players. The average age of the participants was 21 ± 0.6 yrs, body mass: 53.7 ± 7.20 kg; body height: 166.7 ± 6.6 cm. Each participant performed three full-force kicks with the dominant leg. To be included in the study, participant should have an experience of 3 years in professional soccer. All participants were in good health and without any condition that could significantly impact the test results. Each subject provided consent for participation.

Variables:

Five variables were chosen for the evaluation of kinematic parameters. The following were considered independent variables: KA-S (the angle of the knee joint in the starting phase of the swing of the swing foot (degrees)); LL (the length of the last step (cm)); SD (the distance from the support leg to the ball (foot posterior displacement; cm)); and KA-SL (the knee angle of the support leg at the time of contact with the ball (degrees)). Additionally, we considered one dependent variable: VB (the speed of the ball (m/s)).

Procedure:

All testing was conducted out door. The participants wore outfits that complied with the conditions of testing. The participants performed a 15min warm-up, which consisted jogging, jumping, dynamic stretching and exercises with a ball. Testing commenced at the end of the warm-up.

The participants began the test by kicking with the dominant leg. Each kick was completed three times. The subjects rested for one minute between kicks, in order to prepare for the next kick. Each kick ended with a three-step run that started within 4 m from the ball and was at an angle less than 45° to the goal. The kick was performed at a distance of 10 m from the goal. Each kick was recorded by a high speed camera (Sony) that were positioned perpendicular to the plane of the kick. The testing space was calibrated. The cameras had a frequency of 100 fps.

Statistical Analysis:

Multiple correlation analysis evaluates prediction of one criteria variable based on a defined group of prediction variables. Multivariate regression analysis provides the multiple correlation (R) and β coefficients, which are fundamental standardized coefficients of partial regression. The multiple correlation coefficients express the strength and interconnection of a group of predictors and criteria variables; it rates the value of the total system of prediction variables in the prediction of one criteria variable. Each of the variables within the prediction system has its own β coefficient. The higher this coefficient, the more impact the variable has on the prediction of the criteria variable. The β coefficient is similar to the partial correlation coefficient because it shows separate contributions of individual variables in defining common variations of the group of predictors and the criteria variable.

Results:

Within the applied regression analysis, the independent variables included the evaluation of kinematic parameters. The criteria variable was presented as the speed of the ball for each attempt and it was expressed in m/s. The results of the regression analysis are presented in Table 1. On the basis of our results, the regression analysis was terminated in the second step, where R = 0.690. The coefficient of multiple determination (R^2), which represents the percentage of variability and was a joint criteria to the group of prediction variables in the second step, equalled 0.476.

Table No: 1
Regression Analysis

			Model summary			ANOVA	
Model	Coefficient	Significance					
	β	Standard Error	R	R²	Standard Error	F	p
Constant	4.130	0.000	0.690	0.476	1.827	16.371	0.000
SD	-2.130	0.042					

The values of the β coefficients were calculated for each of the steps of the regression analysis. Analysis of the individual impacts of predictor variables to the criteria revealed that one variable offered a significant portion of the prediction of the characteristic of the dependent variable. SD was the variable, along with the partial correlation with the dependent variable, that had a statistically significant impact on the prediction of the dependent variable.

Table 2 presents the mean values of the variables, SD, and Vball, as well as the coefficients of correlation between these independent variables and the dependent variable (the speed of the ball).

Table No: 2

	Mean	Standard Deviation	V Ball
SD (the distance from the support leg to the ball)	12.11	5.43	r=-.316
V Ball (velocity of the ball)	26.82	3.72	

Discussion:

Our results clearly demonstrate that the velocity of the ball primarily depends on the position of the support leg when performing the kick (Tanaka et al, 2006). Specifically a smaller distance between the ball and the support leg contribute to a higher speed of the ball. This is due to the creation of a high force impulse and, at the same time, an increase in the phases of compression and restitution (Opavsky, 2000; Droge et al., 2002; Asai et al., 2005). Dorge et al. (2002) reported that a high speed of the foot (18.6 m/s) and a high angular velocity (28.1 rad/s) led to a high coefficient of restitution (COR = 0.50), where a larger COR means a higher coefficient of elasticity of the ball and thus, a higher ball speed. Additionally, Asai et al. (2005) explained that a high force impulse (Ns = 11.06 ± 0.33 kg m/s) was associated with a high speed of the foot (23.12 ± 1.03 m/s) and a high speed of the ball (25.44 ± 0.76 m/s). Hussain and Arshad Bari (2012) defined a positive correlation between the speed of the foot and the speed of the ball (r = 0.94). Further, Poulmedis et al. (1998) stated that a high angular speed was positively correlated with the speed of the ball (r = 0.64 – 0.82).

Our results also show that positioning of the support foot has a significant impact on the achieved speed of the ball. Coefficients reported (r = −0.316) show that a large distance between the support foot and the center of the ball results in a lower speed of the ball (similarly, a small distance between the support foot and the center of the ball results in a high speed of the ball). The reason for the smaller speed when the support leg is positioned farther from the center of the ball is probably due to the fact that the impulse of the kicking force is directed to the center of the ball (Opavsky, 2000; Shinkai et al., 2009). Andersen et al. (2008) reported that the coefficient of restitution was highest at the lowest acceleration of the foot (11.9 m/s), when the force impulse was closer to the center of the ball. Conversely, the highest acceleration (16.1 m/s) occurred when the force impulse was directed farther away from the center of the ball.

Technically advanced players firm the kicking leg to the body at the moment of kicking the ball and, therefore, increase the amount of body mass that participates in the kick (Opavsky, 2000; Reilly, 2003). Despite other factors and variables, we acknowledge that the technical quality of the player is important in achieving an efficient kick. Shan et al. (2012) defined the connection of kinematic parameters with the speed of the ball based on biomechanical modeling of the entire body. The correlation coefficients for novice, advanced, and professional players were 0.754, 0.913, and 0.951, respectively. The correlation coefficients for novice, advanced, and professional female players were 0.728, 0.911 and 0.953, respectively. As previously stated, alterations in positioning of the support leg relative to the center of the ball contribute to different speeds of the ball. Positioning of the support leg is conditioned by the swing angle. Finally, different swing angles and different positions of the support leg result in different ball speeds. Some research showed that a swing angle of 45° generates the maximum speed of the ball (Isokawa and Less, 1998). Scurr and Hall (2009) reported mean values of variations in positioning of the support leg and achieved speed of the ball at different swing angles, resulting in the highest average speed of the ball (supporting foot lateral displacement from the ball: 45°, 34.6 ± 6.1 cm, V ball 34.47 ± 2.12 m/s supporting foot posterior displacement from the ball: 45°, 11.3 ± 9.1 cm, V ball 34.47 ± 2.12 m/s).

Length of the final step in the swing determines acceleration or deceleration of the foot and can significantly impact the speed of the foot and, ultimately, the speed of the ball. Potthast et al. (2010) determined that substantial decelerations in the final step were correlated with a high speed of the ball ($r = 0.60$). Slowing of the center of the body contributes to the acceleration of the open end of the kinetic chain and, as such, leads to a high speed of the foot. The speed of the ball is also largely impacted by the position of the foot of the kicking leg. Ishii and Maruyama (2007) explained that the speed of the ball increased when the contact surface used to kick the ball was closer to the center of the foot of the kicking leg because the force (impact force 1200 N) resulted in an average highest speed of the ball (16.3 m/s). In the instep kick, the natural position of the body and foot allows for a high speed of the foot of the kicking leg and a high speed of the ball, unlike some other kicking techniques. Levanon and Dapnea (1998) determined that speed of the foot and speed of the ball are lower with the side-foot kick (foot speed 19.1 ± 1.1 m/s; ball speed 23.4 ± 1.7 m/s) than with the instep kick (foot speed 20.3 ± 1.0 m/s; ball speed 28.0 ± 2.1 m/s).

On the basis of our results, we may conclude that there is an optimal position of the support foot that can lead to increased speed of the ball. Our findings confirm earlier research observations that a high speed of the ball is achieved if the support foot is positioned closer to the ball (Harrison and Mannering, 2006).

Conclusion:

This study suggests that there was one factor that contribute to increased speed of the ball in an instep kick in soccer, i.e. positioning the support leg as close to the center of the ball as possible what allows the ball to be kicked with a large surface area of the foot that was close to the center of the foot.

Our conclusions were based on the correlations between observed kinematic parameters and the speed of the ball. Therefore, for a soccer player to successfully adopt this technique, he/she must pay attention to the technical elements presented in this paper.

References:

- Amiri-Khorasani M, Osman NAA, Yusof A. Kinematics Analysis: Number of Trials Necessary to Achive Performance Stability during Soccer Instep Kicking. J Hum Kinet. 2010;23:15–20.
- Andersen TB, Kristensen LB, Sorensen H. Biomechanical Differences Between Toe and Instep Kicking – Influence of Contact Area on the Coeefficient of Restitution. 2008. Available at: http://www.shobix.co.jp/jssf/tempfiles/journal/2008/019.pdf; accessed on 2013/05/06.
- Asai T, Carre MJ, Akatsuka T, Haake SJ. The curve kick of a football I: impact with the foot. Sports Engineering, I. 2005;5:183–192.
- Barfield RW, Kirkendall TD, Yu B. Kinematic instep kicking differences between elite female and male soccer players. J Sports Sci Med. 2002;1:72–79.
- Dorge HC, Bull Anderson T, Sorensen H, Simonsen EB. Biomechanical differences in soccer kicking with the preferred and the non-preferred leg. J Sports Sci. 2002;20:293–299.
- Harrison A, Mannering A. A biomechanical analysis of the instep kick in soccer with preferred and nonpreferrerd foot. XXIV International Symposiumm of Bimechanics in Sports; ISBS – Conference Proceedings Archive; University of Limerick, Salzburg, Austria. 2006. pp. 1–4. ISSN 1999-4168.
- Hussain I, Arshad Bari M. Biomechanical evaluation of ankle force during instep kicking. 2012. Available at: http://www.isrj.net/ArticleDetalls.aspx?id=746; accessed on: 2013/07/06.
- Ishii H, Maruyama T. Influence of foot angle and impact point on ball behaviour in side-foot soccer kicking. The Impact of Technology on Sport. 2007;II:403–408.
- Isokawa M, Less A. A biomechanical analysis of the instep kick motion in soccer. In: Reilly T, Lees A, Davids K, Murphy WJ, editors. Science and Football. London: E & FN Spon; 1998. pp. 449–455.