INVESTIGATION OF SOCCER KICKING FOR PROFICIENT AND NON-PROFICIENT SOCCER PLAYERS

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The purpose of this study was to identify the kinematic differences between proficient and non-proficient players during soccer kick. We hypothesize that there are significant kinematic differences between the proficient and non-proficient players as they aim to hit a specific target. Six subjects were recruited for the study. A marker-based motion capture system was used to capture the lower extremity joint kinematics during soccer kick. Our results showed that proficient subjects displayed larger maximum hip flexion angles during initiation phase and lower maximum hip flexion during kick phase for the right target, as compared to the non-proficient subjects. These differences may be useful considerations in developing a neuromuscular training program to increase the proficiency of hitting a specific target during a soccer game.

KEY- WORDS: soccer, proficiency, target, angles, lower extremity joints.

INTRODUCTION: Soccer is one of the most popular sports around the world and it is played and watched by millions of people around the world. Soccer kicking is the most widely studied skill in soccer, whereby the accuracy of this skill has been suggested to be dependent on ball speed, ball position, and the nature and intent of the kick (Less & Lonald, 1998). During the kicking movement, the leg functions as an open kinetic chain. The motion pattern of kicking is generally accepted as a proximal–to-distal sequence of segmental motions in which the proximal segment (thigh) initiates the movement, causing the more distal segment (shank and foot) to lag behind, followed by a deceleration of the proximal segment and an acceleration of the more distal segment just before impact (Dörge,2010). Recently, Kawamoto et al (2007) found that the mean ankle dorsiflexion angle for the inexperienced group was considerably smaller than that of the experienced group just before impact, which suggests that experience level can influence lower extremity joint kinematic profiles during soccer kick. However, there is still a lack of understanding on whether lower extremity joint kinematics can affect the proficiency in hitting different target locations. Therefore, the objective of this study was to investigate the kinematic differences between proficient and non-proficient subjects as they aim to hit left-side, center and right-side targets. These differences may be useful considerations in developing a neuromuscular training program to increase the proficiency of hitting a specific target during a soccer game.

METHODS: Six healthy male subjects were recruited from the local university, with a mean age of 23 ± 2years, height of 1.74 ± 0.08 m and weight 66 ± 8 kg. All subjects were right-leg-dominant. The exclusion criterion was a history of lower extremity injuries/diseases that might affect kicking biomechanics. All the subjects signed informed consent before participation, in accordance with the university's Institutional Review Board. Anthropometric data such as, height , weight, shoulder off-set, elbow width, wrist width,

hand width, knee width ,ankle width, leg length and inter-anterior superior iliac spine distance were acquired from the subjects. To eliminate the effect of shoe type on the subject performance, all subjects wore the same F50 shoe model (ADIDAS, Germany) sizes from 9-11.

A motion-capture system (Vicon MX, Oxford Metrics, UK), consisting of eight infrared cameras, was employed to collect kinematic data at a sample rate of 100Hz. The force-plates were synchronized to the motion capture system; both were calibrated according to the manufacturer's recommendation before the kick trials were conducted. Thirty-five retro reflective markers (14-mm diameter) were attached to the subject's full body based on the Plug-In-Gait Marker set, to facilitate capture of the subjects' soccer kicking motion.

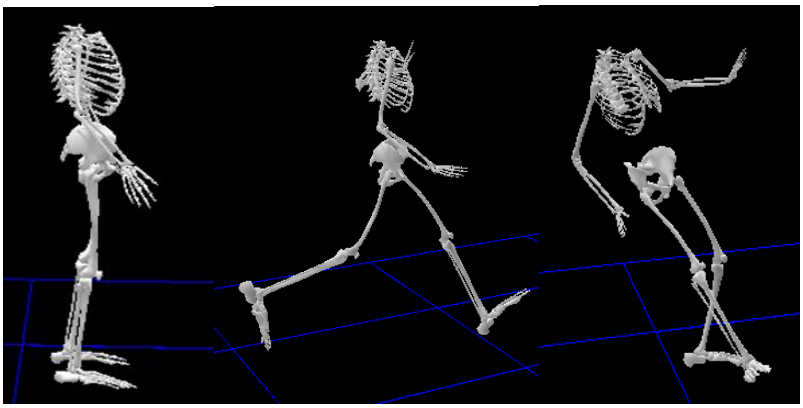
One white board (170 x 190cm) was placed at a distance of 5.5m away from the kicking point. The white board was divided in small squares of 5cm per side, with the purpose of to quantify the deviation in x axis and y axis. Three targets (15-cm diameter), marked in black, were placed in the bottom corners and in the center of the board, and were labeled starting from letter "A" to letter "C".

The subjects were instructed to perform a soccer kick, using their natural kick style. The subjects were given 5 min of practice and 5 min of rest before commencing the actual kicking trials. A trial is considering a successful when the subject hit the white board. Three trials were conducting per target and the results were averaged from each set of three trials. The sequence of targets to kick was randomized in this study using a random number generator. Each subject was told the letter of the target to hit, prior to kicking the ball. All the trials were video-recorded to facilitate the determination of the deviation between the ball's contact with the white board and the actual target position. For the purpose of this study, we classified the subjects into proficient and non-proficient players, according to the target deviation obtained when they attempted to hit the target (Table 1).

Table 1. Summary of mean (±SD) target deviations between proficient and less proficient subjects.* significant difference (p<0.01)

	Deviation (cm)		
Target Location	**Proficient**	**Non-Proficient**	**p-value**
Right	23.0±5.5	104.0±8.9	<0.001*
Center	19.6±2.8	91.0±9.78	<0.001*
Left	22.6±4.3	93.1±36.8	<0.001*

The software, Vicon Workstation 5.1 and Polygon 3.5, were used for data collection and processing respectively. The kinematics data were smoothed using a Woltring filter. The peak angle for the hip, knee, angle, shoulder, elbow and wrist during the three phases of soccer kick. The initial phase was taken as the time between the heel contact of the dominant leg and heel contact on the non-dominant leg. The kick phase was taken as the contact of the non-dominant leg and the foot contact with the ball.. The two phases are represented in the Figure 2. Student t-test (OriginLab, OriginLab Corporation, USA) was performed to determine the difference in target deviation between proficient and non-proficient subjects. Two-factor (target location x proficiency) ANOVA, followed by Holm-Sidak post-hoc testing, was used to compare the lower extremity joint angles at different target positions between proficient and non-proficient subjects, and the interaction between target location and proficiency.



A B C

Fig.2 The two phases of a soccer kick: Initiation phase (between A and B), and Kick phase (between B and C).

RESULTS: We found a significantly lower target deviation ($p<0.001$) at all targets for the proficient subjects, as compared to the non-proficient subjects (Table 1). Interestingly, for proficient subjects, we noted a markedly higher maximum right hip flexion angle during initiation phase ($p<0.01$) and lower maximum right hip flexion angle ($p<0.001$) during kick phase, when they tried to kick the soccer ball towards the right-side target (Table 2). In addition, we found a lack of interaction between proficiency and target locations for most lower extremity joint kinematics, except for the hip ($p<0.001$) (Table 3).

Table 2. Summary of mean (±SD) of maximum joint angles between proficient and non-proficient subjects for the three different targets, in sagittal plane.
*** Significant difference ($p<0.05$)**

Maximum Joint Flexion Angles (degrees)					
Target Location	**Joint**	**Phase**	**Proficient**	**Non-Proficient**	**p-value**
Left target	Hip	Initiation	17.9±11.7	21.8±19.9	0.870
		Kick	21.0±14.7	36.4±12.6	0.141
	Knee	Initiation	28.6±26.0	24.2±17.8	0.766
		Kick	65.63±21.2	59.2±7.0	0.680
	Ankle	Initiation	22.9±10.3	24.0±13.5	0.900
		Kick	9.3±2.6	39.6±38.3	0.700
Center target	Hip	Initiation	42.5±23.3	20.0±30.4	0.406
		Kick	27.7±5.1	39.4±20.6	0.337
	Knee	Initiation	26.6±13.4	22.9±9.0	0.807
		Kick	53.0±16.3	64.9±7.9	0.440
	Ankle	Initiation	32.8±9.8	26.5±14.7	0.487
		Kick	8.4±5.6	15.8±6.1	0.327
Right Target	Hip	Initiation	74.7±9.0	21.6±3.9	0.030*
		Kick	25.6±8.0	78.5±8.0	<0.001*
	Knee	Initiation	15.8±17.8	34.4±20.1	0.233
		Kick	48.3±24.2	48.1±24.8	0.990
	Ankle	Initiation	27.7±6.5	17.3±6.2	0.257
		Kick	4.1±13.5	14.6±8.0	0.275

Table 3. Interaction p value between target location and proficiency.
*** Significant difference (p<0.001)**

Interaction p-value			
	Joint		
Phase	Hip	Knee	Ankle
Initiation	0.470	0.479	0.649
Kick	<0.001*	0.671	0.840

DISCUSION: There is limited understanding of the lower extremity joint kinematic differences between proficient and non-proficient players when they kick a soccer ball towards a specific target location. The purpose of this study was to investigate and identify the differences in sagittal plane lower extremity joint kinematics between proficient and non-proficient players. Altogether, our results indicated two major findings: (1) proficient subjects displayed larger maximum hip flexion angles during initiation phase and lower maximum hip flexion during kick phase for the right target, as compared to the non-proficient subjects, and (2) proficiency can influence the accuracy of the shots hit at the various target locations, especially through hip joint kinematics. Collectively, our findings suggest that proficient subjects tend to exert better right hip control, through lower maximum hip flexion, in order to achieve a precise hit at the right-side target. In addition, the hip joint appears to play an important role, as compared to knee and ankle, in determining whether a subject can kick proficiently at different target locations. One constraint of this study was perhaps the use of the natural kicking style. Although a standardized kicking style would offer more experimental consistency, it would be difficult to instruct the subjects a standardized kicking technique due to their varying learning experience and capabilities. Moreover, the use of natural kicking style benefited us in investigating how the subjects would naturally coordinate their lower extremity joints in order to hit a specified target. Future work will likely involve the analysis of frontal plane joint kinematics, which may be potential factors that can contribute to the proficiency of a subject in hitting center and left-side targets.

CONCLUSION: This study identified the key kinematic differences between proficient and non-proficient players when they tried to hit a specific target. The results may be useful in developing neuromuscular training programs that may help to increase the accuracy of soccer players in scoring goals.

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