

GAME PERFORMANCE ANALYSIS OF SOCCER GOALKEEPERS COMPARISON BETWEEN SAVING MOTION AND OTHER MOTIONS Naoki Numazu¹, Norihisa Fujii², Masao Nakayama², Masaaki Koido²

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The purposes of this study were to clarify the most important goalkeeper (GK) motion of the various motions, such as saving motion and other motions to evaluate the performance and to analyze the most important motion biomechanically. Data were obtained from 27 official games from 2014 Kanto University League and others. The novel findings in this study are summarized as follows: (1) the corresponding motion to the shot was the important motion in the performance of goalkeepers in comparison with other performances. (2) it is assumed that the saving motion with the preparatory motion should be analyzed preferentially for improvement of GK motion, (3) corresponding motion to the centering and throwing are the second and third most important motions for the GK next to the corresponding motion to the shot during a game.

KEY WORDS: performance analysis, university soccer, goalkeeper, preparatory motion

INTRODUCTION: Preventing the opponent from scoring is one of the most important factors for winning a soccer game. A lot of researches were conducted on passes and shots (Hughes and Franks, 2005). According to the previous studies about performance of goalkeepers (GKs), Baranda, Ortega, and Palao (2008) reported that the performance which was most frequently performed by GKs was saving motion. In the biomechanical analyses of the saving motion of GK (Isokawa, Sakuma, Togari, Ohashi, and Suzuki, 1986; Graham-smith and Lees, 1999), it was reported that GKs performed a jump lightly as a preparatory motion and performed crossover steps before saving motion to dive to a distant place. Their previous studies, however, did not analyze the diving motion to correspond to the shot by kicking. It is still unclear what kind of GK motion is the most important to evaluate GK performance. Therefore, the purposes of this study were to clarify the most important GK motion of the various motions, such as saving motion, goal kick, long pass, motion corresponding to the centering, throwing, back pass, clearance, and break away to evaluate the performance and to analyze the motion biomechanically.

METHODS: Basic data were obtained in 27 official games of Tsukuba University from 2014 Kanto University League, the qualifier and finals of the Emperor's Cup 2014, and the qualifier of the Prime Minister Cup 2014. 54 GKs were sampled for analyses (Tsukuba University and opponent teams). 1398 performances of GKs were recorded on videos, 303 corresponding motions to the shot and 1095 other performances (goal kick, back pass, clearance, corresponding to the high balls, throwing, and break away).

MEASUREMENT ITEMS: First step; we classified the corresponding motion to the shot in seven items referenced by Isokawa, Sakuma, Togari, Ohashi, and Suzuki (1986) and Graham-smith and Lees (1999) as follows. (a) Saving motion with preparatory motion (jumping lightly), (b) saving motion after side step with preparatory motion, (c) saving motion after side step (without preparatory motion), (d) only saving motion, (e) fisting without saving motion, (f) catching a shot, (g) looking a shot (measuring only goals against). Second step; we checked whether GKs performed preparatory motion before the saving motion or not (presence or absence of preparatory motion). Third step; we checked whether the player shots the ball was inside of the penalty area or outside (shot area). Last step; we checked the height of the ball at the goal (shot height). We divided the height of the ball into three parts (high, middle, and low). And we also checked seven motions except the corresponding motion to the shot as follows. (1) goal kick, (2) long pass (including pant kick), (3) throwing after the ball catching, (4) corresponding motion for centering, (5) back pass, (6) clearance, (7) break away.

STATISTICAL ANALYSIS: The Chi-squared test was used to analyze motions corresponding to the shot, presence or absence of preparatory motion, shot area, and shot height. The statistical significance level was set at 0.05. MATLAB was used for the statistical processing of all data. Two analysts were separately engaged in taking the measurements by pausing and replaying videos repeatedly. Reliability of the measurements of motions corresponding to the shot was evaluated by examining 52 corresponding motions randomly extracted from the 5 games of the overall sample. Calculations were made of the κ variable for the four items of motions corresponding to the shot, preparatory motion, shot area, and shot height, which are category variables. As a result, the κ variables were 0.94 for motions corresponding to the shot, 0.86 for presence or absence of preparatory motion, 0.95 for shot area, and 0.82 for shot height. The mean variable was 0.89, which showed that the measurement were reliable.

RESULTS: Table 1 shows statistical values of motions of corresponding to the shot and comparison between the saving motion with preparatory motion and other motions. In all of motions corresponding to the shot, the saving motion with preparatory motion is most counted (117/303 times). There are significantly differences between the saving motion with preparatory motion and other motions corresponding to the shot (each $df = 1$, $p < .05$).

Table 2 shows statistical values of all performances and comparison between the corresponding motion to the shot and other performances. In all performances, the goal kick is most counted (383/1398 times) and the corresponding motions to the shot are secondly counted (303/1398 times). The corresponding motions to the shot were significantly fewer than goal kick ($df = 1$, $\chi^2 = 9.33$, $p < .05$), on the other hand, corresponding motions to the shot were significantly more than other performances (each $df = 1$, $p < .05$).

Table 3 shows comparisons between the presence and absence of preparatory motion, and comparison between the conditions of success of shot stop and the failure of shot stop. In the condition of the success of shot stop, the amount of presence of preparatory motion counted 184 times and the amount of the absence of preparatory motion counted 49 times. In the condition of the failure of shot stop, the amount of presence of preparatory motion counted 25 times and the amount of the absence of preparatory motion counted 45 times. In all conditions, presence of preparatory motion were significantly more than absence of preparatory motion ($df = 1$, $\chi^2 = 47.10$, $p < .05$).

Table 4 shows the shot height with conditions of success of shot stop and the failure of shot stop. In all conditions, Low is most counted (success: 160 times, failure: 34 times) ($df = 2$, $\chi^2 = 11.14$, $p < .05$). As a result of calculation of the conditioned residual error, in success of shot stop condition, there is significantly difference between High and Low ($p < .01$). In failure of the shot stop condition, there is significantly difference between High and Low ($p < .01$).

Table 5 shows the shot area with conditions of success of shot stop and the failure of shot stop. In all conditions, inside of the penalty area was more counted (success: 166 times, failure: 63 times) and difference significantly more than outside of the penalty area ($df = 1$, $\chi^2 = 10.30$, $p < .05$).

Table 1 comparison of corresponding motions to the shot.

Mesurement items	All motions (n=303)	Chi-square value (df=1)	difference (vs. Saving motion with preparatory motion)
Corresponding motions to the shot			
Saving motion with preparatory motion	117		
Saving motion after side step with preparatory motion	20	68.67	*
Saving motion after side step without preparatory motion	18	72.60	*
Only saving motion	22	64.92	*
Fisting without saving	15	78.81	*
Catching a shot	81	6.55	*
Looking a shot	30	51.48	*

*: $p < .05$

Table 2 comparison of corresponding motions to the shot with other performances.

Mesurement items	all performances (n=1398)	Chi-square value (df=1)	difference (vs. motions corresponding to the shot)
Corresponding motions to the shot	303		
Goal kick	383	9.33	*
Long pass	203	19.76	*
Throwing	124	75.03	*
Corresponding motion to the centering	97	106.09	*
Back pass	209	17.25	*
Clearance	36	210.29	*
Break away	43	195.37	*

*: p<.05

Table 3 comparisons of the preparatory motion.

	Presence of preparatory motion	Absence of preparatory motion	χ^2 test difference
Success of shot stop	184	49	$\chi^2 = 47.10$
Failure of shot stop	25	45	df=1 p < .05

Table 4 comparisons of the shot height (top) and conditioned residual error (bottom).

	High	Middle	Low	χ^2 test difference
Success of shot stop	38	35	160	$\chi^2 = 11.14$
Failure of shot stop	23	13	34	df = 2 p < .05

	High	Middle	Low	** : p < .01
Success of shot stop	-3.02 **	-0.71 n.s.	3.07 **	
Failure of shot stop	3.02 **	0.71 n.s.	-3.07 **	

Table 5 comparisons of the shot area.

	Inside of penalty area	Outside of penalty area	χ^2 test difference
Success of shot stop	166	67	$\chi^2 = 10.30$
Failure of shot stop	63	7	df=1 p < .05

DISCUSSION: In our study, corresponding motion to the shot which GKs performed most was "Saving motion with preparatory motion". Nunome, Asai, Ikegami, and Sakurai (2002) reported the average ball speed of the instep kick was 28.0 ± 2.1 m/s. This indicates that shots from the penalty area (16.5 m from the goal) can reach the goal in about 0.5 s. So, GK must correspond to the fast shot and move very quickly. If GK corresponds the shot after side step, it is assumed that the motion time becomes longer. Therefore, it is suspected that GK has changed the position to correspond to the shot and GK performed the saving motion with the preparatory motion before a shooter makes the kick. Moreover, considering the relationship of shot height, shot area, and corresponding motions to the shot, it is assumed that GK must correspond to the fast shot at various heights.

In addition, in the success of the shot stop, GKs performed the preparatory motion before the saving motion which reported by Isokawa, Sakuma, Togari, Ohashi, and Suzuki (1986). GKs in this study performed fewer preparatory motions in failure of the shot stop. Uzu, Shinya, and Oda (2009) reported that performing the preparatory motion before the main motion in tennis is effective to move more quickly than a static posture. GK save the shot in response to the kicking motion of the shooters. So, it is assumed that GK also performed the preparatory

motion such as a tennis player.

Graham-Smith and Lees (1999), however, didn't report that GK performed preparatory motion. Because they focused on the difference of the saving motion to various places, they didn't report the preparatory motion but GKs have performed preparatory motion in the trials. It is assumed that the preparatory motion is important motion for GKs. Therefore, the saving motion with the preparatory motion should be analyzed preferentially for improvement of GK motion.

In general, Goal kick, Long pass, Back pass, and clearance are called "ball controlling". Ball controlling is important ability for all soccer players. Baranda, Ortega, and Palao (2008) reported that the saving motion and ball controlling were the performances which were most often performed by GK in the 2002 FIFA World Cup. Similar results in university soccer games were obtained in our study and the corresponding motions to the shot are important motion. In addition, the throwing and the corresponding motion to the centering are much counted motions in our study. It is assumed that these performances are also important motions for GK next to the corresponding motion to the shot during a game.

CONCLUSIONS: The purposes of this study were to clarify the most important GK motion of the various motions, such as saving motion and other motions to evaluate the performance and to analyze the motion biomechanically. The new findings in this study are summarized as follows: (1) the corresponding motion to the shot was the important motion in the performance of goalkeepers in comparison with other performances, (2) it is assumed that the saving motion with the preparatory motion should be analyzed preferentially for improvement of GK motion, (3) corresponding motion to the centering and throwing are the second and third most important motions for GK next to the corresponding motion to the shot during a game. These findings might be useful to improve a GK coaching.

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