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Kinematics Analysis of Taekwondo Kick with Visual Feedback

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ABSTRACT- The purpose of this study was to evaluate kinematics of Taekwondo side kick when visual feedback was present or absence. A total of 10 collegiate Taekwondo Pumsae athletes (age: 21±2.558 yrs, height: 166.91±7.354 cm, weight: 59.909±7.856 kg, level: 4.364±0.481, career: 9.818±3.996 yrs) were recruited for the study, and the time required, height, and angle of body segment were analyzed using 13 Optitrack's infrared cameras. Results indicated that the total time spent for executing the side kick motion was 0.518±0.095s in the absence of visual feedback (CF) and 0.506±0.056s in the presence of visual feedback (LM) ($p>.05$). In addition, the ratio of the foot height of the kicking leg to the individual body height was 100±5% in the absence of visual feedback and 101±5% in the presence of visual feedback ($p>.05$). The results of kinematic analysis suggested that when using visual feedbacks, the faster and higher side kick were observed.

KEYWORDS- Poomsae, Taekwondo, Feedback, Kinematics

I. INTRODUCTION

The kick, which can be considered the core of Taekwondo, is a technique to strike a target with the foot, and is a technique to subdue an opponent by striking with the foot, and is a technique to attack with the power of bending or straightening the knee or swinging the leg [1, 2]. Since a score is made by hitting with a power greater than the set power, the kick must be fast and strong, and instantaneous power and speed are greatly required [1,2,3]

There are three major modalities in Taekwondo; Sparring, Demonstration, and Poomsae [4,5,6,7] sparring requires various strategies, so it is important to do it with a partner, and the demonstration requires objects that can be broken and the help of an assistant. The kicks during demonstration requires a flashy technical kick and requires a lot of knee snap and speed to break many boards in one motion. Since sparring and demonstrations are more about striking than precise posture, many people practice kicking mitts during training [5,6,7]. However, Poomsae is a sport that does not require the help of an assistant, so it can be trained alone. Poomsae matches are played by maximizing an individual's skills without the influence of others and minimizing the penalty points within the established game rules to determine the winner and loser, so the amount of individual training greatly affects the performance. Unlike the sparring and demonstration kicks, the kick during Poomsae must be executed in the air and the empty space without a set target [3,5,7]. Accordingly, the ability to control one's own body and sense of balance are greatly required during the Poomsae. In order to be good at Poomsae, training and repeated practice for the accuracy and expressiveness of movements are necessary [4].

When practicing individually, the individuals need feedbacks on your own movements, but since he/she cannot immediately see him/herself, many athletes film themselves or use mirrors to check the accuracy of the movements. When training, mirrors provide visual information to the trainee's movements simultaneously and continuously, and the trainee can observe his or her movements through the mirror, detect errors, and perform self-correction and self-analysis [8].

The purpose of the present study was to compare kinematics of the side kick movements with mirror feedback: LM (looking at the mirror) and without mirror feedback: CF (situation specified in the regulations: looking at the tips of the feet), thereby providing basic data on the relationship between visual feedback and kicking movement performance.

II. METHODS

A. *Participants*

The subjects of this study were 10 collegiate Taekwondo Poomsae athletes and they had experience participating in national Poomsae competitions. After receiving a preliminary explanation of the study, they participated in the experiment after filling out a consent form and a pre-test questionnaire. All subjects used their right foot as their main foot and also performed kicking with their right foot. The characteristics of the subjects are shown in see table 1). Written informed consent was obtained from each participant prior to the experiment. Before participating in the study, all participants completed a brief questionnaire regarding their personal information such as height, weight, and age.

Table 1: Personal Data

	Age(yr)	Height(cm)	Weight(kg)
M	21	166.91	59.90
SD	2.55	7.354	7.85

B. *Procedure*

The participants were asked to do sufficient stretching and warm-up for 30 minutes to perform the movement smoothly and prevent injury after receiving a sufficient explanation of the experiment and completing a consent form and a prior

questionnaire. A mirror and a curtain to cover the mirror were installed on one wall of the lab, and 13 infrared cameras were installed for video recording. The subjects performed a side kick movement at a pre-marked point to collect and analyze the video data. The arrangement of the experimental tools is as shown in figure 2. The global coordinate system of the lab space is set with the origin at the right rear of the subject when looking at the subject from the front, and the left direction is set as the X-axis, the vertical direction is set as the Z-axis, and the Y-axis is set as the cross product of the two vectors.

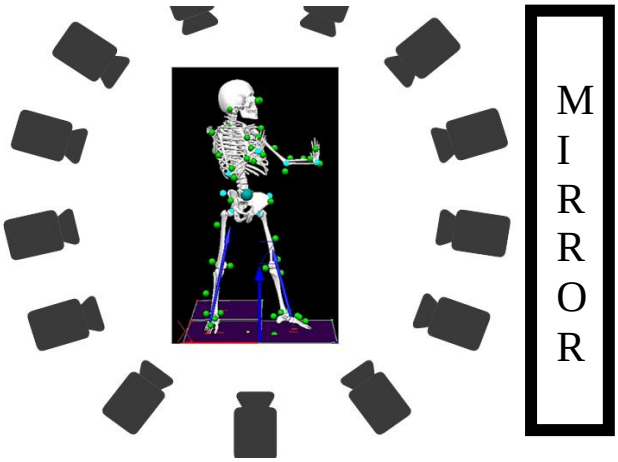

Figure 2. View of Experimental Set-up

A commercial software was used for the analysis and processing of the collected three-dimensional kinematic and kinetic data. Both kinematic and kinetic data underwent a fourth-order Butterworth digital low-pass filtering, with cutoff frequencies of 6 Hz and 10 Hz.

The movements performed by the subjects were divided into 3 events and 2 phases for the purpose of presenting the research results, as follows:

- ***Event setting***

  E1: The moment when the kicking foot begins to lift off the ground.
  E2: The moment when the knee of the kicking leg is maximally flexed.
  E3: The moment when the knee of the kicking leg is maximally extended.

- ***Phase setting***

  P1: From the moment when the kicking foot begins to lift off the ground to the moment just before the knee of the kicking leg is maximally flexed. (E1 ~ E2).
  P2: From the moment when the knee of the kicking leg is maximally flexed to the moment when the knee of the kicking leg is maximally extended. (E2 ~ E3).

In order to find out the difference in the kinematic variables of Taekwondo kicking according to visual feedback, t-test was performed statistically using the SPSS 26.0 program, and the statistical significance level was set at $p<.05$.

III. RESULTS

The results of analyzing the time required for each section and the difference in each situation during the Taekwondo side kick movement with and without mirror feedback are as shown in table 2.

Table 2: Analysis results of time required for each section of side kick according to presence or absence of mirror feedback (unit: s)

group		P1	P2	P1-P2
CF	M	0.28	0.24	0.52
	SD	0.06	0.08	0.10
LM	M	0.29	0.21	0.51
	SD	0.04	0.03	0.06
t-value		0.74	1.00	0.68
p-value		0.47	0.33	0.51

The results of analyzing the difference in foot height according to the presence or absence of mirror feedback during the Taekwondo side kick movement, foot height relative to body height(F/B), and situational differences are as shown in table 3.

Table 3: Analysis of kick height during side kicks with and without mirror feedback (unit: m)

group		Height	F/B
CF	M	1.654	100%
	SD	0.112	5%
LM	M	1.668	101%
	SD	0.092	5%
t-value		0.29	0.28
p-value		0.776	0.78

IV. DISCUSSION

The present study analyzed the Taekwondo side kick movement according to the presence or absence of mirror feedback (with mirror feedback: LM, without mirror feedback: CF) and analyzed the effects of mirror feedback on the total execution time and the ratio of foot height to the kick height of taekwondo side kicks.

When examining the time required for the side kick motion depending on the presence or absence of mirror feedback, LM was 0.012 sec faster than CF in the total time required, but CF was 0.017 sec faster than LM in P1 (from the moment the kicking foot leaves the ground to the moment just before the kicking leg's knee is maximally flexed). However, LM was 0.029 sec faster than CF in P2 (from the moment the kicking leg's knee is maximally flexed to the moment the kicking leg's knee is maximally extended). In the study [9], the performance times for the side kicks of excellent players were P1: 0.29 s, P2: 0.29 s, and the total time required was 0.58 s, which were similar to the results of this study. Shortening the time required for a roundhouse kick helps improve the kicking performance of excellent players [10], and efficient roundhouse kicks can be performed by shortening the time required by increasing the speed in the kicking direction [3,5]. It was suggested hat it is ideal to perform a side kick motion by quickly increasing the vertical force and propulsive force to shorten the time required [3,6,9,10,11,12]. Therefore, although there was no significant difference in the time required for a side kick motion depending on the presence or absence of mirror feedback, it is thought that mirror feedback affects the ideal performance of the motion, as the time required was shorter in LM.

Although there was no significant difference, LM was 0.014 m, 2% higher than CF. When there is no mirror feedback, it is difficult to reach the target point because the field of view

can change depending on the inclination of the upper body. However, when there is mirror feedback, one can see one's entire appearance through the mirror, so one can set a target point for height, confirm the process and moment of reaching the targeted height with one's own eyes, and control sway by seeing the movement of the body through the shape reflected in the mirror, as in the study which was thought to have resulted in a high score because one can control one's movements by looking at the mirror.

V. CONCLUSION

There was no significant difference in the analysis of the time required for side kicks depending on the presence or absence of mirror feedback. There was no significant difference in the analysis of the height of side kicks depending on the presence or absence of mirror feedback.

VI. RESEARCH QUESTION

What other factors will be affected by mirror feedback training compared to no mirror feedback training?

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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REFERENCES

[1] Z. Liu, M. Yang, K. Li, and X. Qin, "Recognition of TaeKwonDo kicking techniques based on accelerometer sensors," *Heliyon*, vol. 10, no. 12, p. e32475, 2024. Available from:https://www.cell.com/heliyon/fulltext/S2405-8440(24)08506-2

[2] U. Moenig, "The evolution of kicking techniques in Taekwondo," *Journal of Asian Martial Arts*, vol. 20, no. 1, 2011. Available from: https://shorturl.at/VrKNK

[3] P. J. Vilas-Boas, Ed., *ISBS 2011: 29th International Conference on Biomechanics in Sports; Porto, Portugal, June 27 - July 01, 2011*, 2011, pp. 219-222. Available from: https://ojs.ub.uni-konstanz.de/cpa/article/view/5013

[4] S. Thibordee and O. Prasartwuth, "Effectiveness of roundhouse kick in elite Taekwondo athletes," *Journal of Electromyography and Kinesiology*, vol. 24, no. 3, pp. 353-358, 2014. Available from: https://doi.org/10.1016/j.jelekin.2014.02.002

[5] J.-W. Kim et al., "The effects of target distance on pivot hip, trunk, pelvis, and kicking leg kinematics in Taekwondo roundhouse kicks," *Sports Biomechanics*, vol. 9, no. 2, pp. 98-114, 2010. Available from: https://doi.org/10.1080/14763141003799459

[6] L. Dos Santos Banks et al., "Accuracy of a markerless system to estimate the position of Taekwondo athletes in an official combat area," *International Journal of Performance Analysis in Sport*, pp. 1-16, 2024. Available from: https://doi.org/10.1080/24748668.2024.2321738

[7] J.-h. Kim, "Differences in dance learning effects according to mirror use," M.S. thesis, Graduate School of Education, Ewha Womans Univ., 2015.

[8] Y.-S. Noh, "Biomechanical analysis of Taekwondo Poomsae side kick movement," M.S. thesis, Graduate School of Sports Science, Dankook Univ., 2012.

[9] C.-S. Yang, "Kinematic comparison of roundhouse kicks in Taekwondo and Hapkido," *Journal of the Korean Society of Exercise Biomechanics*, vol. 10, no. 2, pp. 157-164, 2001.

[10] H. Zhou, "Martial arts moves recognition method based on visual image," *Journal of Information Processing Systems*, vol. 18, no. 6, 2022. Available from: https://doi.org/10.3745/JIPS.02.0188

[11] L. Dos Santos Banks et al., "Accuracy of a markerless system to estimate the position of Taekwondo athletes in an official combat area," *International Journal of Performance Analysis in Sport*, pp. 1-16, 2024. Available from: https://doi.org/10.1080/24748668.2024.2321738

[12] S.-T. Son, "The effect of mirror feedback in balance training," M.S. thesis, Daegu Catholic Univ., 2012.