KINEMATIC AND TEMPORAL CHANGES OF SLIDE STEP DELIVERIES OF BASEBALL PITCHERS DUE TO TECHNICAL TRAINING AIMING TO SHORTEN THE MOTION TIME

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The purpose of this research was to evaluate the motion and time change by training aiming at shortening the slide step delivery time of baseball pitchers. Six collegiate baseball pitchers were participated in the experiment as participants. They performed three fastball pitches with full effort (both as fast and quick as possible) by slide step deliveries before (Pre) and after (Post) one-month training period. For the phase time, there were significant differences between Pre and Post in the Phase 1 and total. There were no significant differences in Phase 2 and Phase 3. The lift height of the knee of the stride leg showed no significant difference. Therefore, to shorten the time of stride phase without decrease the lift height of the knee of the stride leg is necessary to shorten the slide step delivery time.

KEY WORDS: stride leg, quick release of the knee, motion time

INTRODUCTION: In baseball, when runners are on the base, pitchers must do “slide step delivery”, a faster delivery of the ball to the catcher, to prevent stolen next base by runners (as below, the term “SSD” can be defined as slide step delivery). Although there are many studies about baseball pitching motion, there is little studies about the SSD. Reducing the time for SSD is important to prevent the runner from being stolen. Several studies on the motion of SSD have been conducted (Keeley et al, 2012; Keeley and Gretchen, 2010; Plummer et al., 2010). But they are compared with the usual throwing motion, and no research has been made on the time reduction by training of SSD. It is thought that analyzing the motion and time change by training to shorten SSD time will lead to useful suggestions to the coaching site. The purpose of this study was to compare before and after the training about the change in motion and time due to technical training to shorten SSD time to collegiate baseball pitchers.

METHODS: Six collegiate baseball pitchers (72.8 ± 6.9kg, 1.78 ± 0.1m, age: 19.2 ± 0.4 years) were participated in the experiment as participants. Their team is belonging to the first division of collegiate baseball league, and some of them are belonging to the top team of them. Therefore, these subjects were thought to represent the level of Japan varsity baseball pitchers. Participants were informed of the procedure and study aims before the start of the measurements. At the pre and post experiment, each participant performed three fastball pitches with full effort (both as fast and quick as possible) by SSD after warming up with running and dynamic stretching exercises. The trials that showed the highest ball velocity were used for analysis. Three high-speed cameras (GC-L20B, Sports sensing Co, LTD, Japan) were used to collect images at a rate of 240 Hz.

Participants pitched the baseball with SSD before (Pre) and after (Post) training session. Training period was one month and six days for each week. Practice times were depended on each participant for one practice session. The content of the technical training was composed by the author based on the “quick release of the knee” movement which was constructed with hints from traditional Japanese martial arts movement.

Frame Dias IV (DKH Corp, Japan) was used to digitize 24 body segment points and ball which identified via markers. Then, calculated three-dimensional coordinates of these measuring points using the Direct Linear Transformation (DLT) method (Abdel-Aziz and Karara, 1971). Matlab (The MathWorks, Natict, MA) was used for data processing. The coordinate data were digitally filtered independently in the X, Y, and Z directions. Lift height of the knee of the stride leg were calculated and compared with Pre and Post sessions. Figure 1 shows the phase of SSD. The motion was divided into three phases by four instants: start of stride foot movement, maximal knee height (MKH), stride foot contact (SFC), and ball release (BR). Two-way repeated analysis of variance (ANOVA) was performed to compare each parameter between Pre and Post test, and to test the significance of the main effects as well as interactions (between groups × sequential change) among the groups. Bonferroni/Dunn’s test was used to the Post hoc test and set at $p = .05/3$ or $p < .0168$.

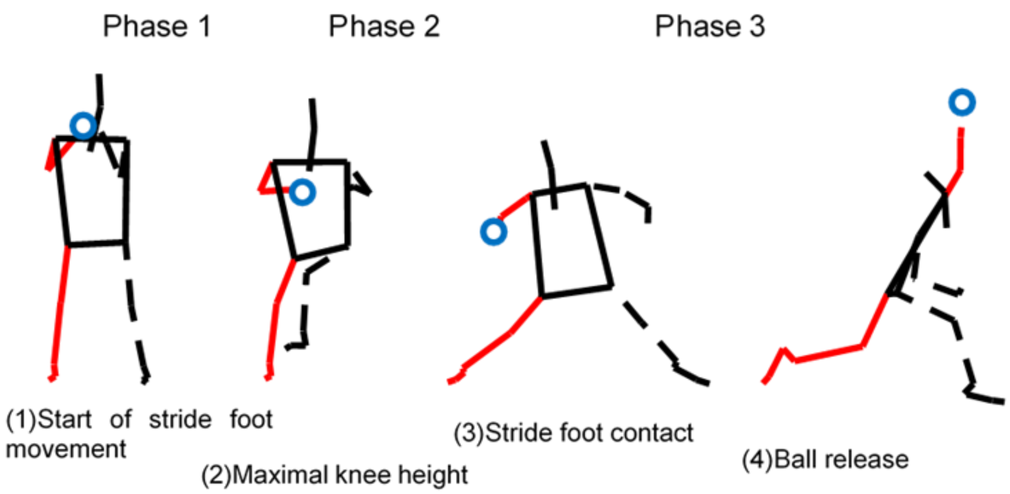

Figure 1. The phase of slide step deliveries motion.

RESULTS: There was a non-significant difference for the ball velocity between Pre and Post (Pre: 122.47±4.85 km/h, Post: 118.92±3.79 km/h, n.s). Figure 2 shows the difference of each phase time and total time of SSD between Pre and Post test. There were significant differences for Phase 1 (Pre: 0.41±0.11 s, Post: 0.27±0.11 s) and Total (Pre: 1.05±0.13 s, Post: 0.91±0.13 s). In addition, there was a non-significant difference for Phase 2 (Pre: 0.51±0.03 s, Post:

0.50±0.04 s, n.s). There was no significant difference for Phase 3.

Figure 3 shows the lift height of the knee of the stride leg at MKH. There was no significant difference between Pre and Post (Pre: 0.18±0.05 m, Post: 0.16±0.03 m, n.s). There were some differences for pivot leg kinematics, but no differences for upper body kinematics.

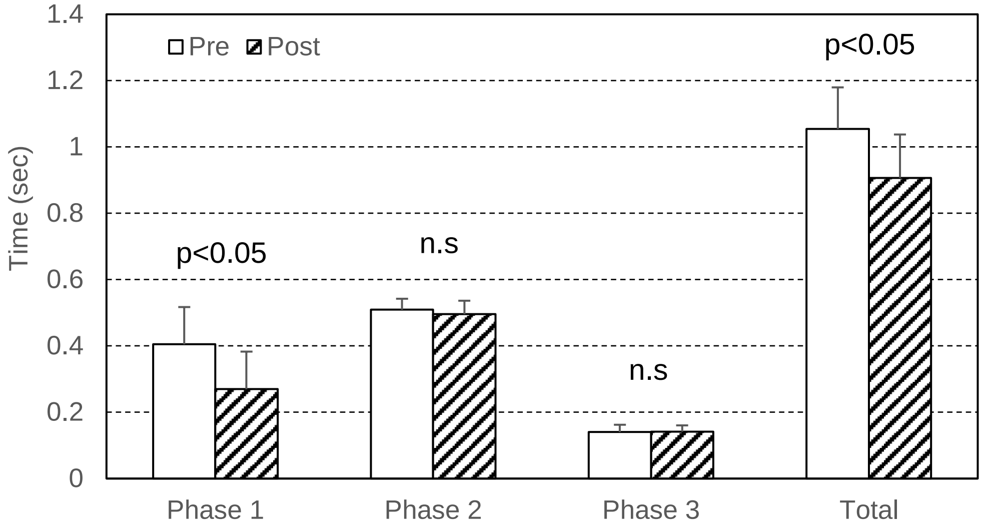

Figure 2. Time of each phase and total of slide step deliveries for Pre and Post.

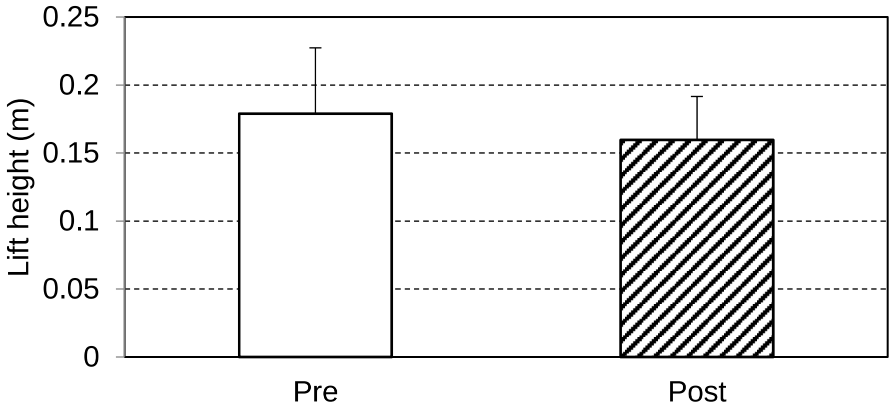

Figure. 3 Lifting height of the stride knee for Pre and Post.

DISCUSSION: After the technical training period, the time of SSD was shortened, and the shortening was brought about by shortening the time of the first phase (Figure 2). Therefore, to shorten SSD time, it is important to shorten the leg lifting motion time. There was no difference in leg lifting height (Figure 3) and upper body kinematics between Pre and Post. Therefore, it is considered that to quickly perform the lifting motion itself of the leg is important rather than lowering the height of lifting the leg without changing the motion of upper body.

The ball speed decreased somewhat in Post, and marginally significant difference was seen. In fact, in the coaching, there is a tendency that the ball speed is reduced as the price to quick movement on SSD. It is important to perform SSD that does not reduce ball speed. Although there were no significant differences for upper body kinematics, it is considered that the decrease in the ball speed was caused by the action of the lower body. It will be important to study kinematics and kinetics of lower body in the future.

CONCLUSIONS: The purpose of this research was to evaluate the motion and time change by training aiming at shortening the slide step delivery time of baseball pitchers. This study identified that, to shorten the time of stride phase without decrease the lift height of the knee of the stride leg is necessary to shorten the slide step delivery time. There were no significant differences for upper body kinematics, and it will be important to study kinematics and kinetics of lower body in the future.

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