

## KINEMATIC COMPARISONS OF TAIWANESE AND VARIOUS FOREIGN VARSITY BASEBALL PITCHERS

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The purpose of this study was to compare the kinematic the pitching motion between Taiwanese, Japanese, Cuban, and American collegeate pitchers (21.9±1y, 1.76±3.8m, 76.6±7.9kg). Kinematic data were analyzed for 10 Taiwanese baseball pitchers, and compared with advanced research by Shimada et al. (2012), Takahashi et al. (2005), Escamilla et al. (2001), and Fleisig et al.(1999). Taiwanese pitchers showed larger peak pelvis rotation angular velocity (Taiwanese: 844.1±215.5 deg/s, Others: 720.2±174.44 deg/s). and smaller rotation angle at release(REL) of Taiwanese pitchers (T: -88.6 ± 9.9 deg) was larger than that of foreign baseball pitchers (O: -92.9±9.3 deg). Due to the kinetic chain, Taiwanese pitchers were unable to transfer the kinetic energy from the lower body to the upper body, and then, they couldn't increase ball velocity.

**KEYWORDS:** pitching, twist rotation at throwing motion, fastball.

**INTRODUCTION:** Taiwanese collegiate baseball players have high level skills by world standards. Studies regarding the throwing motion of Taiwanese pitchers are very few. Escamilla et al. (2002) compared Americana and Korean professional baseball pitchers, and Shimada et al. (2012) compared the pitching motion between Cuban, American and Japanese collegiate baseball pitchers. There were many differences in the pitching motion. Escamilla (2002) stated that training methods differed depending on the culture of the country, resulting in a difference in pitching behaviour, and it is considered that the results of survey by other pitchers cannot be applied perfectly to Taiwanese pitchers. To compare Taiwanese and various foreign collegiate baseball pitchers, it is thought possible to research and clarify the pitching motion characteristics of Taiwanese baseball pitchers. The purpose of this study was to clarify the characteristics of the pitching motion of Taiwanese baseball pitchers by using three-dimensional motion analysis method.

**METHODS:** Ten Taiwanese right-handed over-throw pitchers (body mass: 76.6 ± 7.9kg, height: 1.76 ± 3.8m, and age: 21.9 ± 1 years) participated in the experiment as subjects. Last year, these pitchers won the second division of Taiwanese national championship and reached ninth place in the first division playoffs. Therefore, these subjects were thought to represent the level of Taiwanese collegiate baseball pitchers. After warming up with running and dynamic stretching exercises, each participant performed 10 fastball pitch with full effort. 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 movies at a rate of 240 Hz. Frame Dias IV (DKH Corp, Japan) was used to digitize 24 body segment points and ball manually, and calculated three-dimensional coordinates of these measuring points using the Direct Linear Transformation (DLT) method. This method was similar with Shimada (2012) and Takahashi (2005). Matlab (The MathWorks, Natick, MA) was used for data processing. The coordinate data were digitally filtered independently in the X, Y, and Z directions. Kinematic parameters such as the trunk and hip rotation angle and angular velocity, and ball velocity were calculated and compared with other foreign baseball pitchers. Due to the property of the data, no statistical processing was done.

**RESULTS:** Table 1 shows the body parameters and ball velocity, and Table 2 shows the line ar and angular kinematical data for each group. The ball velocity of Taiwanese (33.6 ± 2.3 m/s) was smaller than other college baseball pitchers (Shimada et al., 2012: 42.4 ± 0.7 m/s; Takahashi et al., 2005: High 35.7 ± 1.0 m/s, Low 33.2 ± 1.1 m/s). Minimum right elbow angle of Taiwanese (54.70±12.20deg) has a smaller angle than other collegiate baseball pitchers(Shi

mada et al., 2012:  $-56.8 \pm 7.2$ deg; Takahashi et al., 2005: High:  $67.1 \pm 11.4$ deg). Minimum right elbow angle at REL of Taiwanese ( $153.54 \pm 5.59$ deg) has a smaller angle than other collegiate baseball pitchers (Shimada et al., 2012:  $162.6 \pm 3.1$ deg). Maximum right elbow extension angular velocity of Taiwanese ( $1,906.38 \pm 274.83$ deg/s) has a smaller angle than other varsity baseball pitchers (Shimada et al., 2012):  $2600.3 \pm 519.1$ deg/s; Takahashi et al., (2005): High:  $2650.1 \pm 394$ deg/s, Low:  $2496 \pm 369$ deg/s). Stride knee angle at SFC of Taiwanese ( $127.86 \pm 10.05$ deg) has a smaller angle than other varsity baseball pitchers (Shimada et al., 2012:  $132.5 \pm 5.61$ deg). Stride knee angle at REL of Taiwanese ( $142.42 \pm 19.75$ deg) has a smaller angle than other varsity baseball pitchers (Shimada et al., 2012:  $144.3 \pm 15.7$ deg). Upper trunk rotation angle at ball release (define as REL) of Taiwanese ( $-67.5 \pm 5.7$  deg) has a larger angle than other varsity baseball pitchers (Shimada et al., 2012:  $-56.8 \pm 7.2$  deg). But the pelvis rotation angle of Taiwanese at REL ( $-88.6 \pm 9.9$  deg) was smaller than that of other foreign varsity baseball pitchers' ( $-92.9 \pm 9.3$  deg). Maximum trunk rotation angular velocity of Taiwanese ( $1176.8 \pm 162.9$  deg/s) was smaller than that of other foreign collegiate baseball pitchers' (Shimada et al., 2012:  $1446.7 \pm 190.7$ deg/s; Takahashi et al., 2005: High  $1263.6 \pm 187.3$  deg/s, Low  $1125.1 \pm 109.7$  deg/s). Maximum pelvis rotation angular velocity of Taiwanese ( $844.1 \pm 215.5$  deg/s) was the fastest compared with other collegiate baseball pitchers (Shimada et al., 2012:  $720.2 \pm 174.44$  deg/s; Takahashi et al., 2005: High  $656.1 \pm 148.9$  deg/s, Low  $704.2 \pm 106.8$  deg/s).

**DISCUSSION:** The data from this study indicated that the ball velocity of Taiwanese pitchers was smaller than that of other foreign collegiate baseball pitcher. In addition, results showed that Taiwanese pitchers rotated their pelvis larger and faster at the REL, while they rotated their upper trunk smaller and slower than other foreign collegiate baseball pitchers (Table 2). In pitching motion of baseball, the mechanical energy generated by the pivot leg hip joint torque passes through the lower torso and the upper torso. Furthermore, it is important to be able to transmit mechanical energy from the thigh to the lower torso by the stride leg hip joint force in the cocking phase.

The data showed higher values than previous studies at the maximum hip rotation angular velocity ( $749.96 \pm 249.95$ ). When the hip joint is used successfully, the rotation of the waist becomes faster and the rotation of the shoulder thereon becomes faster, but when we showed the present data, although the maximum waist rotational angular velocity was fast, the maximum shoulder rotational angular velocity was slow. Taiwanese pitchers that the waist turned enough at the time of release, but the shoulders did not turn enough. In other words, Taiwanese may have released the ball with poor waist rotation. Shimada et al. (2004) indicated that in the energy increasing phase of upper torso, a great deal of mechanical energy flowed into the torso. In addition, the mechanical energy transferred to the upper torso due to the segment torque power significantly related to the ball velocity at the release ( $r = 0.480$ ,  $p < 0.05$ , Shimada et al., 2004). These results suggested that the mechanical energy flows to the upper torso in the energy increasing phase of upper torso and to the throwing arm and ball in the late cocking phase are important to increase the ball release velocity. The lower ball velocities in the Taiwanese players may be a result of poor transfer of power from the lower body to the upper body.

**CONCLUSION:** According to the results of this study, we can be better informed about Taiwanese college baseball players pitching their balls. In order to create the desired speed in the right direction at the final throwing stage, coaches should utilize drills and exercises targeted at increasing torso rotation. I anticipate that this study can help college baseball players in Taiwan and can improve Taiwan's baseball standards.

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Table.1: Study demographic comparisons (Mean±SD)

	This research	Shimada.et al. (2012) (foreign varsity pitchers)	Takahashi.et al (2005)	
	Taiwanese		Japanese	
Subject number	10	8	High: 10	Low: 12
Height(m)	1.76±3.8	1.86±0.06	1.80±0.06	1.77±0.06
Body mass(kg)	76.0±7.9	83.9±7.7	76.9±5.5	72.5±6.8
Ball velocity(m/s)	33.6±2.3	42.4±0.7	35.7±1.0	33.2±1.1

Table.2: Kinematic differences between Taiwanese and foreign varsity baseball pitchers (M±SD)

	Subject number	Stride knee angle at SFC (deg)	Stride knee angle at REL (deg)		
		This research	TWN	127.86±10	142.42±19.7
	JPN	134.75±7.6	139.60±13.6		
Shimada.et al. (2012)	foreign varsity pitchers	132.5±5.6	144.3±15.7		
Takahashi. et al (2005)	HG	114.3±5.6			
	LG	124±6.7			
	Subject number	Minimum right elbow angle at REL (deg)	Minimum right elbow angle at REL (deg)	Maximum right elbow extension angular velocity (deg/s)	
				This research	TWN
	JPN	50.82±11.2	150.36±4.8	1,971.05±363.2	
Shimada.et al. (2012)	foreign varsity pitchers	55.2±8.9	162.6±3.1	2600.3±519.1	
Takahashi. et al (2005)	HG	67.1±11.4		2650.1±394	
	LG	53.7±16.8		2496±369	
	Subject number	Upper trunk rotation angle at REL (deg)	Pelvis rotation angle at REL (deg)	Maximum upper trunk rotation angular velocity (deg/s)	
				This research	TWN
	JPN	11.47±5	-23.83±8.2	1,057.23±246.4	633.05±307.8
Shimada.et al. (2012)	foreign varsity pitchers	-56.8±7.2	-92.9±9.3	1446.7±190.7	720.2±174.4
Takahashi. et al (2005)	HG			1263.6±187.3	
	LG			1125.1±109.7	