CHARACTERISTICS OF THROWING MOTION OF OVERPOWERING FASTBALL COLLEGE PITCHERS

Yuta Hanawa[1], Naoki Numazu[2], Yuta Yamaguchi[2], Naoki Wada[2] and Michiyoshi Ae[2]

Graduate School of Health and Sport Science, Nippon Sport Science University, Tokyo, Japan[1]
Nippon Sport Science University, Tokyo, Japan[2]

The purpose of this study was to compare the motion pattern of overpowering fastball pitchers. The throwing motion of eighteen male college pitchers were analysed using a motion capture system. This study focused on the movements of the pivot leg and the trunk during the preparatory phase. The overpowering fastball pitchers in the present study largely abducted the hip of the pivot leg and leaned the trunk toward the pivot leg during the preparatory phase. That these motions were seen during the preparatory phase would reveal that a key motion to get fast ball speed exist in the preparatory phase.

KEYWORDS: baseball, pitching, fastball, motion analysis.

INTRODUCTION: In baseball, a ball speed is one of indicators of a pitcher's performance. Matsuo et al. (2001) mentioned that one of keys to increase the ball speed would be the pitching motion in the early phase, especially the legs and trunk motion. Takahashi et al. (2005) studied the motion in the stride phase from the maximum height of the leg (MHL) to stride foot contact with the ground (SFC), and reported that excellent pitchers performed a hoarding motion on the pivot leg (right leg in case of a right-handed pitchers) by flexing the hip and knee of the pivot leg. They concluded that the pivot leg in the pitching motion played an important role in weight translation. Kawamura et al. (2012) said that a feature of fast ball pitchers was a larger abduction of the hip joint of the pivot leg during the stride phase. Shimada et al. (2012) pointed out that Japanese pitchers tended to emphasise the translation of the body toward the direction of the pitch, which was considered to be an important point.
The remarks mentioned above have suggested the importance of the lower limbs movement during the preparatory phase of the pitching such as a striding, translation of the body. It is necessary to investigate movements such as the bending of knee joint and fastball pitchers who may inhere some techniques to acquire fastball speed. Therefore, the purpose of this study was to compare the motion of overpowering fastball pitchers with normal college pitchers.

METHODS: Eighteen male college pitchers participated in the present study. They took a set position and threw a ball as fast as possible to the catcher sitting at 18.44 meters away from the pitcher's mound. They threw at least 10 times. The trial for detailed analysis was one pitching motion with the fastest ball speed was recorded on the radar gun. A motion capture system (12 cameras, Arqus, Qualysis, 250 Hz) was used to collect the three-dimensional coordinate data of 47 body three- dimensional measurement points and 4 points on the ball to which reflective markers were attached. The space coordinate system was defined: the direction of the pitch as Y-axis, the direction perpendicular to the Y-axis as X-axis, and the vertical direction as Z-axis.
The three-dimensional coordinate data were smoothed using a Butterworth digital filter at the optimum cut-off frequencies from 8 to 15 Hz determined by the residual method (Winter, 1990). The angles of adduction and abduction of the hip joint of the pivot leg and the segment angles of the pivot thigh and upper torso were calculated. The time-series data of joint and segment angles were normalized to the first phase from the moment of maximum height of the leg (MHL) to the moment when the stride foot contacts with the ground (SFC) as 0 to 91%, and to the second phase from SFC to ball release (REL) as 91 to 100%.
We selected two top pitchers with the highest ball speed, as overpowering pitchers, pitcher A (height, 1.73 m; weight, 69.2 kg; ball speed, 40.2 m/s) and pitcher B (height, 1.72 m; weight,

68.1 kg; ball speed, 39.9 m/s). The averaged motion was created from sixteen pitchers, (height, 1.78 ± 0.06 m; weight, 78.5 ± 7.8kg; ball speed, 37.0 ± 1.3 m/s) by the Ae's method (2007). The coordinate data for the left-handed pitchers were transformed into that of the right-handed pitchers.

RESULTS: Figure 1 shows the stick pictures of the averaged pitchers of normal pitchers (n=16), pitcher A and B. A close observation of Figure 1 revealed that the trunk of pitcher A leaned to the pivot leg side from 50 to 70% more than in the averaged pitchers time, and in case of pitcher B from 10 to 40% time. Pitcher A rotated his hips to the opposite side of the throwing direction from 40% to 50% time, while pitcher B rotated his hips from10% to 50% of the time.

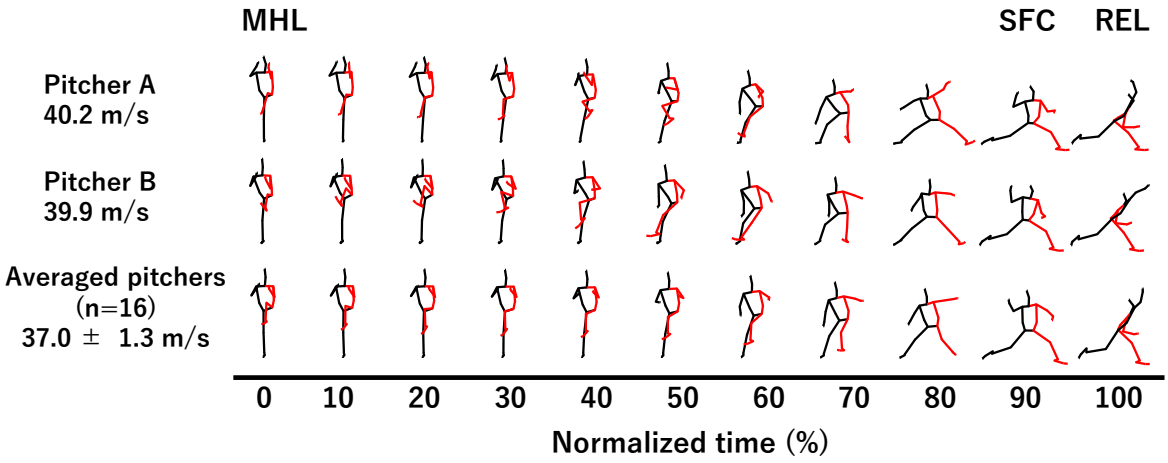

Figure 1. Stick pictures of averaged pitchers (n=16), pitcher A and pitcher B

Figure 2 shows the abduction angle of the hip joint of the pivot leg (in black) for the averaged pitchers, pitchers A and B. In the first phase of the MHL to SFC, pitchers A and B showed different pattern from the averaged one.

The averaged pitchers showed that the hip abduction angle of the pivot leg remained around 15 degrees from MHL to 70%, abducted from 70% to just before SFC, and then rapidly adducted. Pitcher A showed no remarkable change in the hip abduction angle of the pivot leg from MHL to 40%, and he once adducted a little just before he started abrupt abduction at 60% times. Pitcher B abducted slightly larger than the average one at MHL, and via a small abduction he largely abducted the hip joint of the pivot leg after 50 to 80% time.

Pitchers A and B abducted the hip joint of the pivot leg in earlier timing than averaged one. Furthermore, pitcher A indicated a significantly larger hip abduction angle of the pivot leg than the averaged one and pitcher B. (Pitcher A, 53.1°; Pitcher B, 41.8°; Averaged pitchers, 39.6 ± 4.2°)

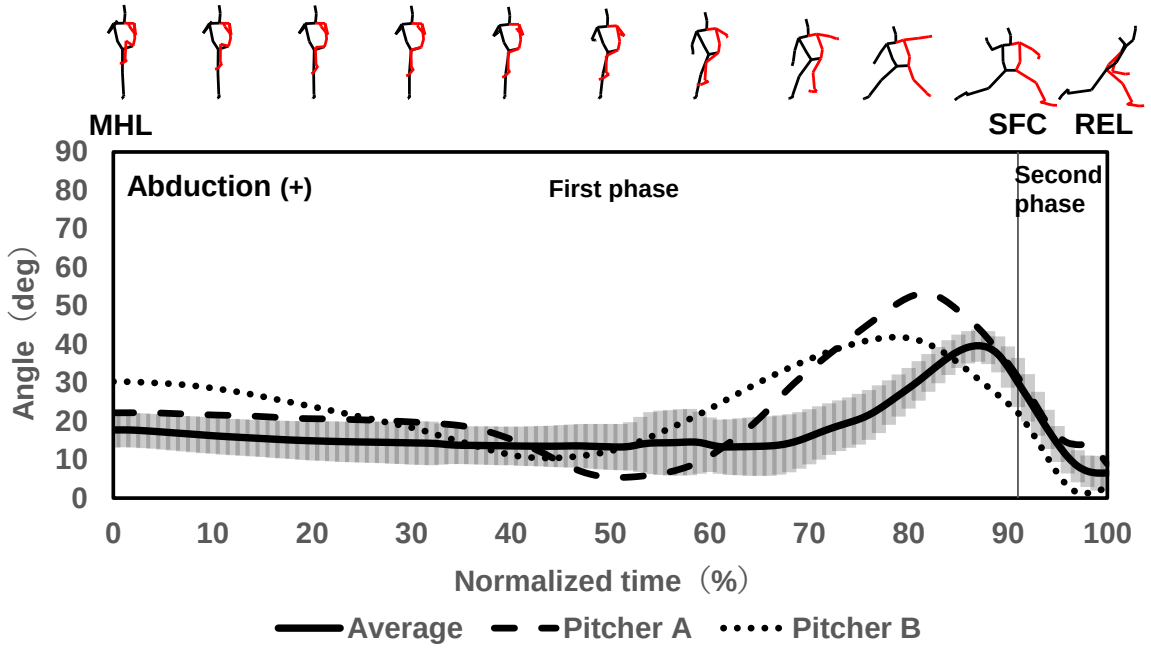

Figure 2: The hip abduction angle of the pivot leg of averaged pitchers (n=16), pitcher A and pitcher B

Figure 3 shows changes in the pivot thigh (in red) and the upper torso angles (in blue) for averaged pitchers, pitchers A and B.

The pivot thigh for the averaged pitchers gradually leaned forward from the MHL to 80%, followed by a small forward and backward change. Pitcher A and B leaned their pivot thigh forward more than the averaged pitchers in the first phase.

The upper torso for the averaged pitchers slightly leaned backward from the MHL to 70%, followed by a large and rapid forward lean after the SFC. Pitcher A leaned his upper torso backward from 50% to 70%, while pitcher B started to lean his upper torso forward from 55%.

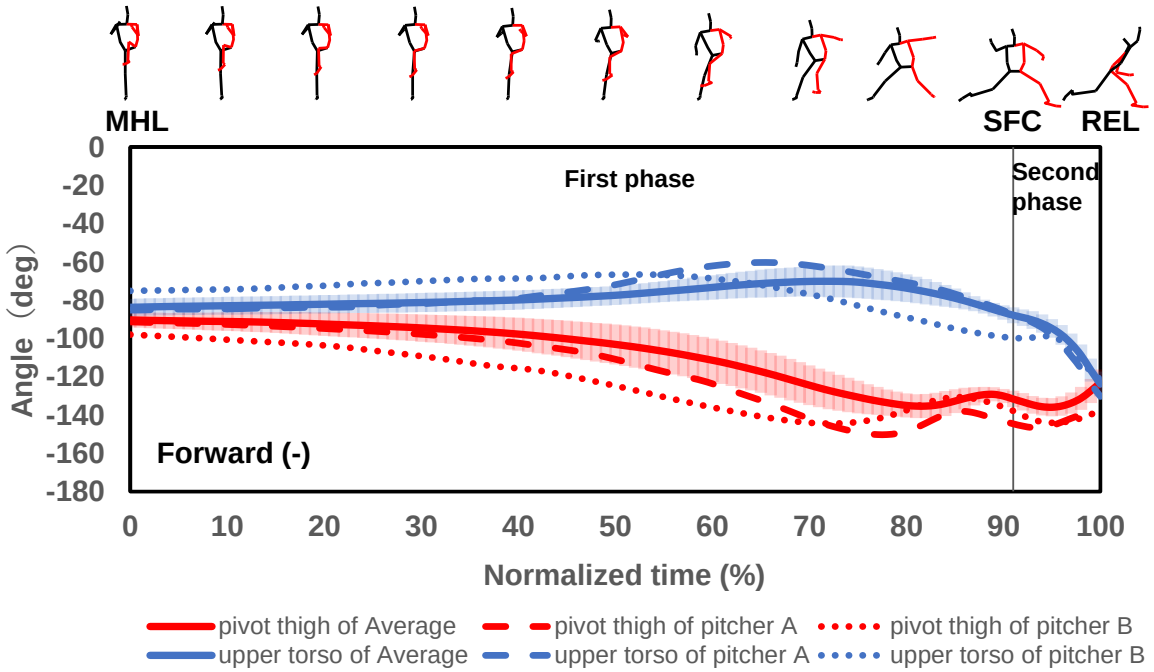

Figure 3: The segment angles of the pivot thigh and upper torso (YZ) for averaged pitchers (n=16), pitcher A and pitcher B

DISCUSSION: The motion variation pivot leg was large in the first phase, and the forward lean of the pivot leg of a pitcher A and B was larger than the large of one standard deviation. This may imply that the forward lean of the pivot leg is a key two increase ball speed. When the pitchers took a large step in the direction of the pitch, the pivot thigh leaned in the same direction, and the abduction of the pivot hip increased. The weight transfer in the direction of the pitch was carried out by the hip abduction torque of the pivot leg (Kageyama et al., 2015). The fastball pitchers transferred their weight in the direction of the pitch while keeping their torso on the pivot leg to prevent their upper torso from moving in the direction of the pitch too early timing (Kageyama et al., 2015). It is thought that pitcher A had a significantly large maximum hip abduction angle of the pivot leg because he opened the pivot leg widely by taking a large stride and leaned his upper torso towards the pivot leg. Based on those findings reported, the motion of pitcher A during the stride phase could be considered as one of features of the fastball pitchers.
As pitcher A, pitcher B opened his pivot leg widely during the stride phase. However, in stepping to the direction of the pitch, the upper torso also leaned. As a result, he did not abduct the hip of the pivot leg as large as pitcher A. Therefore, in order to abduct the hip joint of the pivot leg, the pivot thigh should be opened wide in the direction of the pitch and the pivot thigh should be tilted forward, which would help a pitcher take a long step. In addition, the upper torso should be leaned towards the pivot leg, which would help to make the large of trunk motion larger. In real pitching it would be crucial that both hip abduction and trunk backward lean are well coordinated.

CONCLUSION: The overpowering fastball pitchers in the present study largely abducted the hip of the pivot leg during the first phase, i. e. the preparatory phase. They opened their legs widely and leaned the trunk towards the pivot leg, which would increase the range of motion and the mechanical work. That these motions were seen during the preparatory phase would reveal that a key motion to get fast ball speed exist in the preparatory phase.

REFERENCES

Ae, M., Muraki, Y., Koyama, H., and Fujii, N.（2007）A Biomechanical Method to Establish a Standard Motion and Identify Critical Motion by Motion Variability: With Example of High Jump and Spring Running. Bull. Inst. Health & Sport Sci., Univ. of Tsukuba 30: 5–12.

Kageyama, M., Suzuki, C., Sugiyama, T., Wada, T., Maeda, A. (2015) The relationship between the mechanical power of the lower limbs and ball velocity in university baseball pitchers. Japan J. Phys. Educ. Hlth. Sport Sci. 60 (1): 87-102.

Kawamura, T., Shimada, K., Hirano, Y., Matsuo, T., Hirayama, D., Abe, T., Koyauchi, K., and Ae, K. (2012) The characteristics of pitchers who throw 150km/h. Japan J Biomechanics Academic Journal 16 (1): 32-40.

Matsuo, T., Escamilla R. F., Flesig, G. S., Barrentine S. W., and Andrews, J. R. (2001) Comparison of kinematics and temporal parameters between different pitch velocity groups. J. Appl. Biomech., 17: 1-13.

Shimada, K., Kawamura, T., Hirano, Y., Matsuo, T., Hirayama, D., Abe, T., Okura, K., Ae, K., Kobayashi, Y., and Miyamoto, T. (2012) The pitching motion of the Cuban, American and Japanese teams Japan J Biomechanics Academic Journal 16 (1): 25-31.

Takahashi, K., Ae, M., Fujii, N., Shimada, K., Kawamura, T., and Koike, S. (2005) Kinematic comparison of pitching motion of baseball pitchers whose ball velocity were significantly different. Japan J Biomechanics Sports Exerc 9 (2): 36-52.

Winter, D. A. (1990). Biomechanics and motor control of human movement (4th ed.). John Wiley & Sons, Inc.