

THE KINETIC LINKAGE IN PITCHING MOTION

Kosei Katsuzaki¹, Takeshi Sato², Takayuki Watanabe³, Masami Miyazaki⁴, Shoji Igawa¹

¹Nippon Sport Science University

²Jissen Women's University

³Hachinohe University

⁴Waseda University

The objective of this study was to analyze three-dimensional motion chains of pitching movement, and determine how the chains of movement of the limbs were working together from the lower extremities to the upper extremities. There were divided three experimental groups for comparing the motion skills: professional (n=9), amateur (n=9), and high school (n=9) baseball players. The pitching motion recorded for all subjects performed the maximum their effort from the mound for throwing the ball. It was recorded in videotapes by two high-speed cameras to arrange places. Then four points of every picture were digitized per 1/500 second. Three-dimensional coordinates for the segment endpoints were computed by a direct linear transformation (DLT) method. The result of this study, linking the lower and upper body, professional pitcher could move the body efficient and give the speed for ball. on the other hand, it was found that amateur and high school pitcher could not move the body efficient because to move the shoulder of pitching side to pitching direction.

KEY WORDS: professional, pitching, DLT

INTRODUCTION: The chain of human movement to analyze the kinematic chain in three-dimensional analysis was to get important for physical education. The pitching motion was to attend to skill among the professional, the amateur and the high school players. If the coach want to improve the skills as a player or as a coach then motion analysis was important data. The motion analysis was led it easy for perform powerful high speeds video analysis of any sport using great for pitching as well as Hitting. However it was not enough data to compare how to upper limb moving from the lower limbs in the same protocol. Then the purpose of this study was to investigate comparing the motor skill experiments from high school students, amateur pitcher to professional occupational performance.

METHODS: Subjects were all pitcher of baseball experiments. They were nine leading pitcher that contains the results of three years of 10 wins or more first team player, per season in professional baseball pitchers. In addition, the pitcher of amateur, the name of a total of nine, including one pitcher with an Ace that belongs to the league and college eight pitching ace who belong to baseball rigid member of society that has been called the most prestigious, played in the national tournament, play an active role, belonging to nine high school pitcher baseball team is a rigid school baseball powerhouse high school, and nine and an ace fast bowler.

Sit the catcher at the same position as the game home base is located in the destination 18.44m to warm up enough to be able to throw everything, is a distance regular from mound practice bullpen pitcher each, with the goal of catcher, a fastball was allowed to pitch to throw the ball strike with full force dozens. That was used to throw the ball, the pitcher was used to all the ball games that have been certified with all provisions professional baseball. Also, took a picture ready to throw in the game of the season rather than shooting in the off-season.

Were placed in two places away 2m each side (catcher) and the front side of the mound (the front of the pitcher) pitching form at that time. Pitching direction of the X-axis of the coordinate system, the Y-axis direction perpendicular to the Z-axis is vertical in the pitch direction.

In order to pay attention to the twisting of the upper limbs and lower limbs together with the kinetic chain, point 2, in this study of the throwing arm point 1, the acromion of the throwing

arm to the anterior superior iliac spine side foot wear which is on the opposite side of the throwing arm I plot the point 4 to point 3 hand joint, the elbow joint of the throwing arm. Respect to the image taken by 1/500 second, digitized 4 points using the Elleair software. To obtain a three-dimensional coordinate values by DLT method (Direct Linear Transformation method) using Apas3 dimensional motion analysis software manufactured by Dynamics.

RESULTS: Each part of the operation in relation pitching

The major findings data was shown in Figure 1 on the XY plane hip speed one professional, one amateur and one high school, shoulder joint, elbow joint, wrist velocity at the pitcher releases the fastest in the pitching motion. Gradually increases speed curve is hip, shoulder joint, elbow, and wrist, each pitcher pitching behavior was observed in the kinetic chain pitching motion.

Velocity curve of the shoulder joint of the hip joint point and the maximum speed reached is overlap, the velocity curve of the elbow joint and the maximum speed reaches the point of the shoulder joint overlap, a professional pitcher, velocity curve of the wrist point and reach a top speed of elbow joint overlap showed that the velocity curve and the maximum speed reached a point of each joint overlap. Professional pitcher, there was overlap of points and the velocity curve reaches maximum speed in all three areas of the hip and shoulder joint wrist elbow, and shoulder joint, and the elbow joint.

Amateur pitcher overlap of the wrist velocity curve point and reaching a top speed of elbow joint can be seen, there was no overlap in the velocity curve of the shoulder joint of the hip joint point and reach maximum speed. Not seen any overlap velocity curve of the elbow joint of the shoulder joint and the maximum speed reaches point. Amateur pitcher, there was overlap of points and the velocity curve reaches a top speed of one place in the elbow and wrist.

Overlap of the velocity curve of the shoulder joint of the hip joint point and the maximum speed reached, the overlap of the velocity curve of the elbow joint and the maximum speed reaches the point of the shoulder joint, high school pitcher, the overlap of the velocity curve of the wrist point and reach a top speed of elbow I have not seen. Pitcher in high school, there was no overlap of the velocity curve reaches a maximum speed of all points and three places of the hip and shoulder joint wrist elbow, and shoulder joint, and the elbow joint.

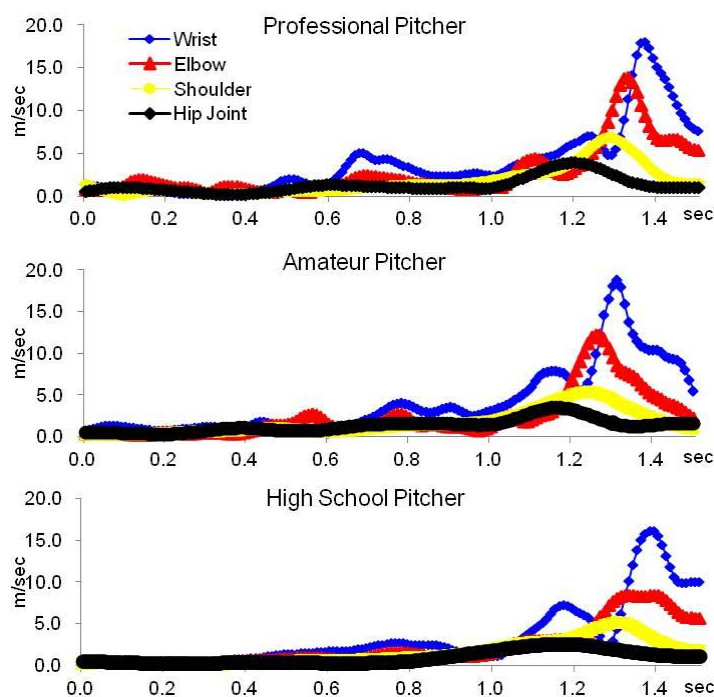


Figure 1. Each joint velocity change of the maximum release rate

Change of motion of the upper limbs and lower limbs

It was to Toru want XY plane is shown in Figure 2 on a stick picture from above one professional and one amateur, one of the largest high school pitchers velocity was released in the pitching motion.

In exercise of the lower limbs, there was translational motion and then you move forward towards professional pitch pitcher and amateur pitcher. Can be seen moving forward while rotating in the right direction rather than in the direction throw, high school pitcher, throwing arm side of the hip joint was seen moving towards the outside.

Rotate around the left shoulder of the opposite side, the shoulder of the throwing arm while the fan-shaped movement was seen in the movement of the upper limbs, and a professional pitcher pitching arm side amateur pitcher, high school pitcher, throwing arm not seen much rotational movement moves forward, the left shoulder of the opposite side were observed translational motion. Rotational motion is not seen in most high school pitcher, was seen moving forward strongly.

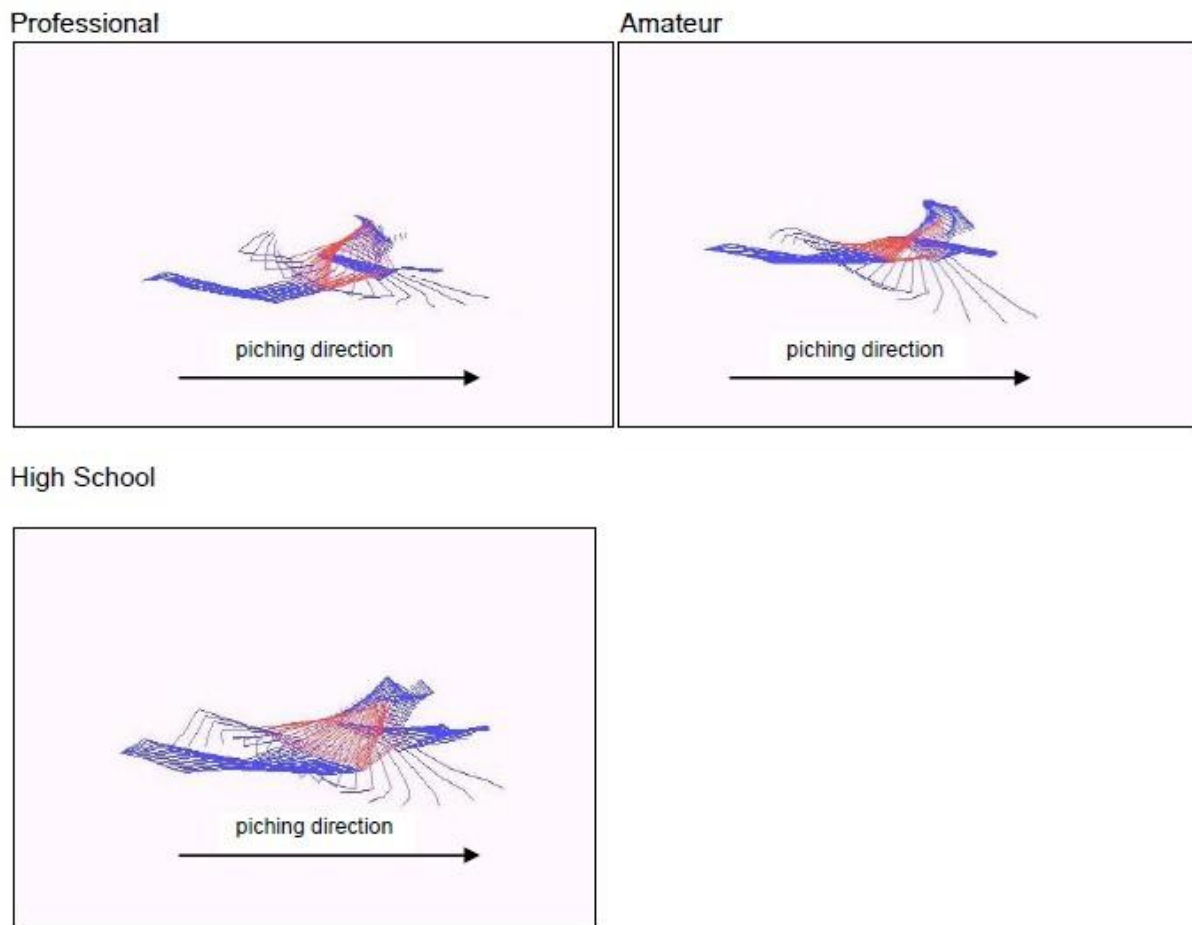


Figure 2: Stick picture from above of the maximum speed of release.

DISCUSSION:

1. Linked of each part in the pitching operation

I was able to see the chain motion with a velocity change of behavior analysis. Pitching motion were observed kinetic chain from the lower limbs to the upper limb from the elbow to the wrist to the elbow joint of the shoulder joint to shoulder joint from the hip joint in all subjects. In order to increase the ball speed, pitching motion must tell you power efficiently to the ball from the end upper limbs, the trunk of the upper limb, lower limb from the trunk from the power of the whole body. During this chain, it is necessary to work efficiently in each adjacent joint. I also considered to be very important timing is to continue to work together to

increase efficiency. As shown in Figure 1, the speed of the shoulder joint is raised is transmitted to the shoulder joint at the same time to reach the maximum speed of the hips joint, the pitcher professional increase the speed of the elbow joint and at the same time reaching the arrival point the maximum speed of the shoulder joint can be seen, been put to good timing chain wrist last, has been completed as a series of acts. Considered very low loss to the releases from the hip as a result. In addition, since the movement held down with a fingertip the ball at the time of its release contains strong, the rate of increase when the only pitcher professional will continue to chain to the wrist joint from the elbow joint This deceleration of the wrist joint is already underway at this time low I have considered.

A pitcher, the importance of the lower limb is often said. It can be fully understood even by the change in velocity of the hip joint. Velocity curve of the hip joint of a professional pitcher for the very smooth, the amateur pitcher, not seen so smooth. As shown in Figure 1, in high school, I find that this maximum rate is very low. In high school, is considered a very high rate of speed increase to the wrist from the elbow joint, than exercise the power of the lower extremities, this is the burden of the elbow joint and the shoulder joint becomes large exercise force only in the upper limbs clearly.

2, Linkage aspect pitching motion

In linked the pitching motion aspect is seen in the lower limb of early cocking phase, the speed of the trunk is very large, long period of time from the windup, and they represent the velocity curve clean. Also, I can be seen have started to increase the speed of the shoulder in the same place deceleration of the hip begins, the kinematic chain efficient perceive. You are considered to produce the energy required for early cocking phase of pitching windup period. Chained to the shoulder joint from the hip joint to the foot sliding speed increases after landing, the late cocking phase, the speed of the shoulder joint, shoulder joint reaches the maximum speed of the period from the early cocking. Energy transfer can be said to be the largest aspect of this phase is carried out on the kinetic chain of the trunk to the shoulder joint, from the lower limbs from the trunk.

It is considered in the acceleration period, and increases the rate of deceleration of elbow to about the same velocity curve of the shoulder joint begins, deceleration of the shoulder joint and the late cocking phase begins. The increase observed in the rate of deceleration of the wrist joint as much as elbow begins at the end. This aspect is considered to transfer energy to the ball at release.

3. Relationship between upper limb and lower limb

It is as shown in Figure 2 the relationship between leg and arm in the pitching operation. Period begins stepped foot stepped out of windup, rotational motion is found in the period before the system goes into cocking phase. Rotational motion is seen going to rotate the rotational motion starts around the hip joint on the opposite side of the throwing arm at the time the foot landed taken, the position of the hip on the opposite side of the throwing arm is at the center. Shoulder joint without a rotational movement in the center, going to move toward the pitch is such that it is inefficient chain suggested in the pitching operation.

Also, I have reported there is a twist action in relation to the upper limbs and lower limbs, the behavior oriented and starts throwing shoulder behind the hip joint. Professional pitcher is seen to rotate around the shoulder joint of the throwing arm. However, in high school pitcher and amateur pitcher throwing arm side of the shoulder joint is moved in the direction you're pitching has been noticeable. It is considered as the difference between the opening of the body of this operation, the front of the body would quickly oriented batter is suggested.

CONCLUSION: Baseball pitcher is pitching when the operation is repeated more than one hundred ball pitching in one game. It is considered that you continue to work for its efficient, stable and able to handle the pitching motion long exercise time. It is also considered the prevention of injury is considered to be a pitcher, pitching and also prevent failure of growth phase. It is considered to lead the integration of efficient work by timing rather than conscious

awareness to accelerate the operation of the terminal operation pitching, throwing, direction, and balance.

REFERENCES:

Glenn S.F, Steve W.B (1997). Kinematic and Kinetic comparison of baseball pitching among various levels of development. *J Biomechanics* 32.

Rafael F.E, Glenn S.F (2001). Kinematic comparison of 1996 Olympic baseball pitchers. *J Sports Sciences* 19: 665-676.

Robertson, M.A. (1977). Stability of stage categorizations across trials: Implications for the 'stage theory' of overarm throw development. *J. Human Movement Studies*, 3: 49-59.

Wild MR (1938). The behavior pattern of throwing and some observations concerning its course of development in children. *Res Quart* 9: 20-24.