ANGULAR ANALYSIS OF THE INDEX AND MIDDLE FINGERS DURING FASTBALL AND CURVEBALL PITCHING – A CASE STUDY

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The purpose of this study was to expand the knowledge by quantifying and comparing finger angle between curveball (CB) and fastball (FB) pitching. One division II college pitcher was participated in present study. A VICON Motion capture system were used to collect 3-D kinematic data (500Hz). Three successful trials for each FB and CB were collected. The metacarpal phalangeal joint (MCP), proximal interphalangeal joint (PIP) and distal interphalangeal joint (DIP) angle was analysed. There were several differences in MCP, PIP and DIP angle for CB and FB. But similar patterns were found between index finger and middle finger. This information may beneficial to conduct thefurther study to explore the mechanics of pitching.

KEY WORDS: throwing, biomechanics, angle

INTRODUCTION:

The purpose of this study was to expand the knowledge by quantifying and comparing finger angle for curveball (CB) and fastball (FB) pitching. Throwing breaking ball is important on baseball pitching. A pitcher with good breaking ball will confused the hitter. One of the common breaking ball is curveball. In the past, coaching curveball depended on their experience, Stockton (1992) think that when pitching a curve ball, the pitcher should place the middle finger in the exact center of the ball and in a straight line with the thumb; the first finger should go next to the middle finger. In previous study, baseball pitching have focused on trunk, shoulder, elbow, and wrist (Elliot et al, 1986, Sakurai et al, 1993, Fleisig, et al, 1998, Barrentine et al, 1998). The lack of finger data limited the understanding of these two pitches (CB and FB).

METHOD:

One healthy collegiate, who is left-hand upper-arm pitcher and plays in Chinese Taipei university baseball association division II volunteered to participate in present study (age 22yr, height 1.68m and 72kg). The subject is good at curveball and fastball. A VICON Motion capture system (Vicon Peak, Lake Forest, CA) with ten digital cameras (MX13) were used to collect 3-D kinematic data (500Hz). Before recording, 26 markers (4 mm in radius) were attached in the skin of the subject. The anatomical nature position data were collected in the first trial. The subject throwed to a target (40 *60cm) which is 3 m in front of the him. Three successful trials for each CB and FB were collected. The joint angle were then computated by Matlab 7.

Eight markers were placed in tunk and upperarm (Figure 1a) for computating the shoulder maximum external rotation (MER). Three markers were placed in the hand for computating the hand coordinated system (Figure 1b,c). Twelve markers were placed in each phalange of index and middle finger for computated the vector of finger segment(J1,J2,J3) (Figure 1b,c). One marker were placed on the ball for computating the ball release event (REL).

The index finger MCP (IMCP) and middle finger MCP (MMCP) was computated in the following sequence: X, Y, Z was the three axis of hand coordinated system. J1a was the projection of J1 on the YZ plane. Radial deviation (J1D) was defined as the angle between J1a and Z. J1b was the projection of J1 on XZ plane. Flexion (J1F) was defined as the angle between J1b and Z (figure 1e). The index finger PIP (IPIP), finger PIP (MIPIP), index finger DIP (IDIP) and Middle and Middle finger DIP (MDIP)angle were computed by the dot product of J1a, J2, J3 (figure 1d).

RESULTS:

During the pitching process, pitchers hold the ball tightly with less finger displacement until arm acceleration started. So only the angular displacement of arm acceleration phase (MER to REL) was presented and discussed in this study. Table 1 and Figure 2 present the data of one trail in FB and CB.

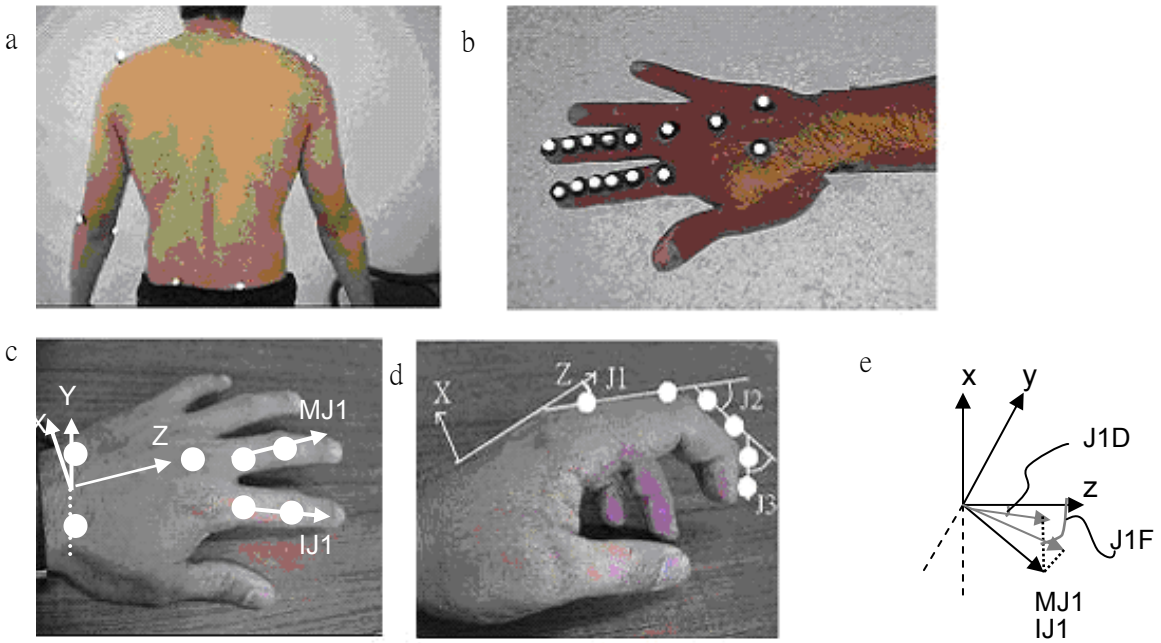

Figure 1- (a). placement of markers on tunk, left shoulder, and elbow (b). placement of markers on left hand (c). hand coloration system and J1 (d). The angle definition of DIP,PIP and MCP flexion (J1F) (e). The angle definition of MCP , ICP radial/unlar deviation (J1D) and flexion(J1D).

Table 1 Angular data in MER and REL in different pitchs

	fastball		cureball	
	MER(°)	REL(°)	MER(°)	REL(°)
Radial－unlar deviation				
IMCP	5.5	15.7	-15.2	-17.6
MMCP	7.6	18.9	-4.4	-3.8
Flexion				
IMCP	4.9	11.7	8.6	10
MMCP	3.6	12.4	25.5	29.2
IPIP	38.3	14.5	39.4	27.7
MPIP	48.7	23.8	41	36.5
IDIP	17.3	19.7	14.5	31.9
MDIP	28.9	28.5	29	26.5

DISCUSSION: The mean ball velocity of FB was 23.25m/s (83.7km/hr) while of CB was 16.90m/s (60.84km/hr). The time of arm acceleration phase were 0.039 sec for FB and 0.032 sec for CB. The ball velocities are slower and the arm acceleration time are longer than those reported by Barrentine et al. (1998) (FB-34m/s,0.024s, CB- 28m/s,0.028s). However, there was a velocity difference between FB and CB and these result was similar with that reported by Barrentine et al. (1998). Those slower ball velocity than the reported literature may caused by the inexperience participant in current study.

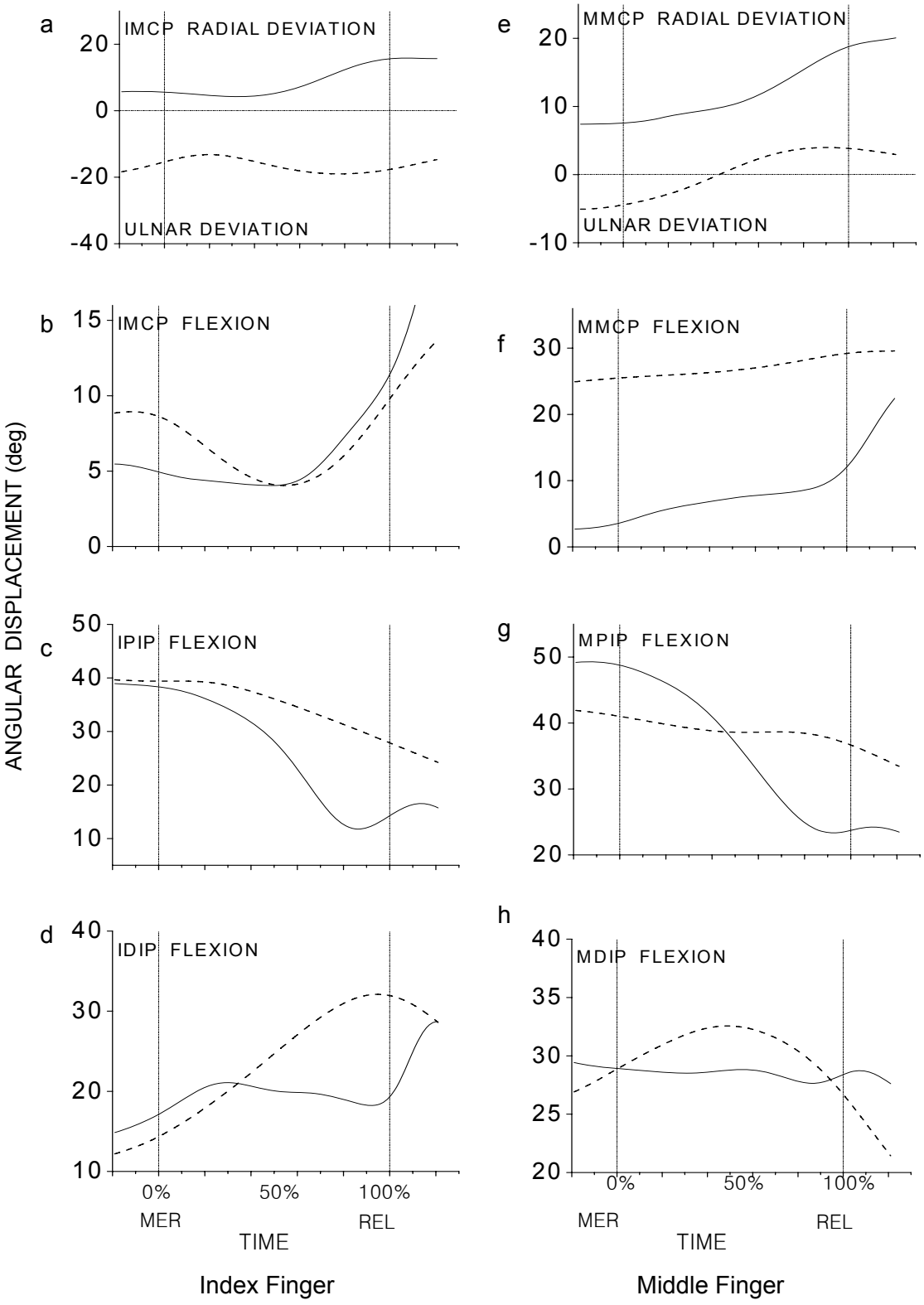

Figure 2— Graphs of angular displacement data versus time from maximum external rotation(MER) until ball release(REL) of one trial for FB and CB. (a) IMCP radial/ulnar deviation, (b) IMCP flexion, (c) IPIP flexion, (d) IDIP flexion, (e) MMCP radial/ulnar deviation, (f) MMCP flexion, (g) MPIP flexion, (h) MDIP flexion. (fastball－, curveball- -)

The radial/ulnar deviation of both pitches (FB and CB) in MCP (IMCP and MMCP) had aapproximate 15° difference during the whole arm acceleration phase (Figure 2a,e). For FB, both MCP had a little radial displacements until 50% of the arm acceleration phase, and then increased rapidly. For CB, IMCP keep around 16° ulnar deviation, while MMCP move from unlar to radial side with a 10° displacement. Accroding the result the pitcher may place the finger to the unlar side for CB from pitch start to REL.
The patterns of IMCP and MMCP flexion were similar in both pitches (FB and CB) (Figure. 2b,f). In IMCP, flexion angle both increased rapidly after 56% of the arm acceleration phase. In MMCP flexion for CB was 20° more than FB. But they all maintained increasing slowerly throughout the arm acceleration phase. The result may show that the pitcher hold ball with a more MMCP flexion for CB than FB when pitching start.
In IPIP and MPIP, flexion for FB decreased rapidly until 90% of the arm acceleration phase, then increase slightly (Figure. 2c,g). But for CB the two joint angles decreased slowerly throughout whole arm acceleration phase. The large flexion for FB may caused by the larger finger force to produce ball velocity.
The angular displacement of IDIP and MDIP flexion were very small for FB (Figure. 2d,h). However, the flexions for CB were increased first and decreased later. IDIP flextion for CB started decreasing at 90% of the arm acceleration phase,while MDIP flextion started decreasing at 50% of the phase. The difference maybe due to the time difference of force applied to these fingers.

CONCLUSION: The purpose of this study was to expand the knowledge for CB and FB by quantifying and comparing finger angle. Similar patterns were found between index and middle finger for FB and CB. But in MCP, PIP and DIP angles, there are several differences. In MCP, radial/ulnar deviation for FB is approximate 15° more than CB, and flexion for FB was 20° less than CB in middle finger, but simillar in index finger. In PIP, flexion for FB decrease more than CB. In DIP, flexion for FB changed more rapidly than CB. This is the first research which present finger motion of baseball FB and CB pitching. Futher study on kinematic, and kinetic of baseball pitchers in different level are needed to gain more understanding of the pitching mechanics.

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