UPPER LIMB KINEMATICS OF BASEBALL BATTING TO DIFFERENT BALL SPEEDS

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INTRODUCTION: Increasing bat velocity and accurately hitting the baseball are important for increasing hit ball velocity. Although there are studies on motion for increasing bat velocity, few studies discussed hitting accuracy in actual baseball batting. Therefore, the aim of this study was to analyze the strategies of upper limbs motion for accurately hitting the ball at different conditions of ball speed.

METHOD: Twenty nine university baseball players volunteered as subjects. Subjects hit a ball pitched by machine at three conditions of ball speed: SLOW (80-85km/h), MEDIUM (100-105km/h), and FAST (125-130km/h). Three dimensional data were collected using Vicon 612 system. A vector from the midpoint of the shoulders to the midpoint of the hands was defined as swinging arm vector. The z axis of the upper torso coordinate system was defined as the vector form the midpoint of the ribs to the midpoint of the shoulders. The y axis was defined as the cross product of z and a vector from the left to the right shoulder. The cross product of y and z yielded x axis. The angle and angular velocities of the swinging arm relative to upper torso and the bat relative to the swinging arm (bat-arm) were calculated.

RESULTS AND DISCUSSION: Table1 shows the maximum, minimum and mean angular velocities of the swinging arm and bat-arm. Although there was no difference in the minimum and maximum angular velocities of the swinging arm, those of bat-arm of FAST were smaller than those of the other conditions. The maximum angular velocity of bat-arm decreased as ball speed increased and occurred after the peak angular velocity of the upper torso (PAUT). PAUT also decreased as ball speed increased in our previous study (Takagi et al., 2008). According to Schmidt and Lee (2005), decreasing movement velocity contributes to accuracy in timing tasks, so it is likely that our batters also constrained their kinetic-chain motion to improve hitting accuracy. However, there might be other causes for the decrease in the maximum angular velocity of bat-arm, such as joint torques and positioning of upper limbs, so the extent of those effects warrants investigation by kinetic analysis.

Table 1 Angular velocities of the swinging arm and bat-arm

		SLOW	MEDIUM	FAST	Difference
Swinging arm	Maximum angular velocity (rad/s)	4.90 ± 1.56	4.61 ± 1.48	4.36 ± 1.11	ns
	Minimum angular velocity (rad/s)	−2.21 ± 1.43	−2.29 ± 1.64	−2.16 ± 1.30	ns
	Mean angular velocity (rad/s)	0.01 ± 0.13	−0.01 ± 0.13	−0.01 ± 0.14	ns
Bat-arm	Maximum angular velocity (rad/s)	27.36 ± 2.51	27.26 ± 1.86	26.44 ± 2.37	M,S>F**
	Minimum angular velocity (rad/s)	−3.56 ± 1.80	−3.23 ± 1.72	−3.00 ± 1.70	S>F**
	Mean angular velocity (rad/s)	0.63 ± 0.21	0.70 ± 0.22	0.74 ± 0.25	S<F*

*p<0.05, **p<0.01 S: SLOW M: MEDIUM F: FAST

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