HEAD MOTION DURING PITCHING AMONG PROFESSIONAL BASEBALL PITCHERS

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INTRODUCTION

The head holds the two most important perceptual systems for detection of self-motion relative to space, the visual and vestibular systems. These two systems provide important information for the control of postural orientation and equilibrium (Horak and Macpherson, 1996). Baseball pitching is a very rapid human motion, where pitching shoulder internal rotation velocity can reach 7000°/s in elite pitchers (Dillman *et al.*, 1993). Maintaining head stability is therefore maximally challenged during baseball pitching. To date, little is known about how the head moves during baseball pitching. The purpose of this study was to characterize the head motion during baseball pitching among professional baseball pitchers.

METHODS

Nine healthy professional baseball pitchers volunteered to participate in this study. The subjects' age was 22.9 ± 2.8 years. Signed informed consents were collected before the testing.

An 8-camera, 3-dimensional motion analysis system (Eagle Digital System, Motion Analysis Corporation, Santa Rosa, CA) was employed to track the pitching motion. Fifteen reflective markers (1.27 cm in diameter) were attached on the anatomical landmarks of the subject's body (Barrentine *et al.*, 1998; Dillman *et al.*, 1993). In addition, three markers, Front Head (FH), Top Head (TH), and Rear Head (RH), were placed to track head motion (Fig. 1). The sampling rate of each camera was 240 frames/s. After normal warm-up routine, the subject pitched 10 fastballs with maximal effort from an indoor pitching mound towards a strike zone target located 18.4 meters away from the pitching rubber.

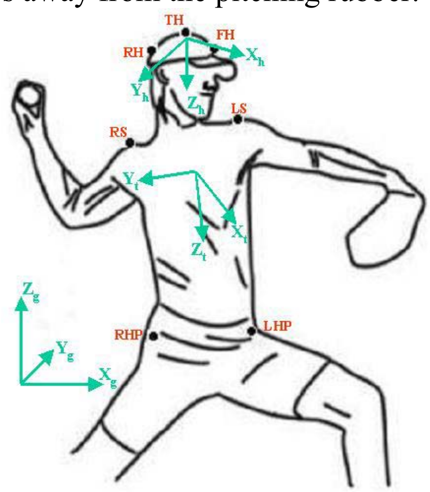

Fig.1. Marker placement and coordinate frames on the head and trunk.

Local head and trunk orthogonal coordinate frames were created. The X-axis of the head frame pointed from marker TH to FH (Fig. 1), Y-axis was the cross product of vector (TH→RH) and X-axis and pointed to the right and Z-axis pointed downwards. The Y-axis of the trunk frame was in the direction from left shoulder marker (LS) to right shoulder marker (RS), X-axis was the cross product of the trunk vector (a vector pointed from mid hip to mid shoulder) and Y-axis, and Z-axis pointed downwards. Head orientations in the trunk frame were calculated as Y-X-Z Euler angles which represented pitch, roll, and yaw angles, respectively. Neutral roll and yaw positions were defined as 0° roll and yaw angles. A static trial was collected with the subject standing upright and looking straight ahead. The pitch angle during the static trial was defined as neutral pitch position. The head orientation angles in the global inertial frame (space) $X_gY_gZ_g$ were calculated using similar methods. For each subject, data from the four highest velocity pitches that hit the strike zone were averaged and analyzed. Results from stride foot contact (FC) to ball release (BR) were time-normalized from 0 to 100% and presented. The head orientation angular velocities were calculated using the five-point central difference method.

RESULTS

In the trunk frame, the average motion of roll, pitch, and yaw were 42.8°, 27.2°, and 78.4°, respectively (Fig.2); the maximum angular velocities were 1403.2, 1155.7, and 1869.0°/s for roll, pitch, and yaw, respectively (Fig.3). In space, the average motion of roll, pitch, and yaw were 20.3°, 5.5°, and 29.3°, respectively (Fig.2); the maximum angular velocities were 536.5, 183.1, and 794.2°/s for roll, pitch, and yaw, respectively (Fig.3).

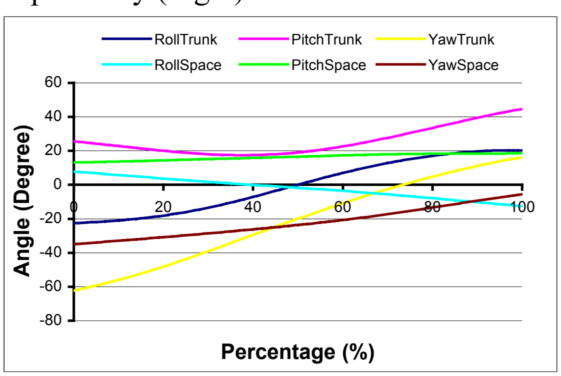

Fig. 2. Head orientation angles from FC (0%) to BR (100%).

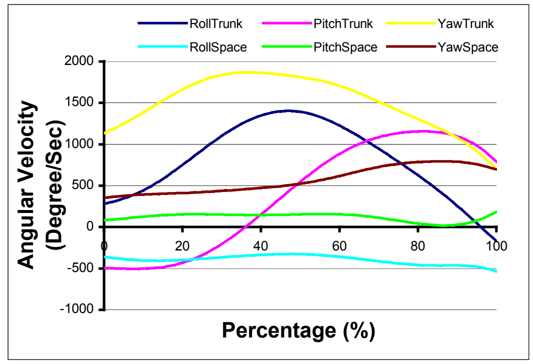

Fig. 3. Head angular velocities from FC (0%) to BR (100%).

DISCUSSION

Both head ranges of motion and angular velocities were greater in the trunk frame than in space, which may be explained by the fact that the head motions in the trunk frame were the combinations of both head and trunk motions. The large ranges of motion and high angular velocities suggested that maintaining head stability during baseball pitching is a very demanding task. In future studies we will try to correlate head motion patterns with other biomechanical characteristics of the pitchers and compare the head motion patterns during different pitch types, which may help us better understand baseball pitching biomechanics.

REFERENCES

Barrentine, S.W. et al. (1998). *J.Orthop.Sports Phys.Ther.* **28,** 405-415.

Dillman,C.J. et al. (1993). *J.Orthop.Sports Phys.Ther.* **18,** 402-408.

Horak,F.B. and Macpherson,J.M. (1996). *Regulation and integration of multiple systems.* 255-292. Oxford University Press.