RELATIONSHIPS BETWEEN TRUNK KINEMATICS AT THE CRITICAL TIME POINTS IN BASEBALL PITCHING

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INTRODUCTION

Baseball pitching is one of the most dynamic movements performed in sports. The high complexity of the movement poses a challenge when learning or instructing pitching technique. While there are many technical points to attend to during pitching, it is theorized that there is a limit in the attentional resources that can be used to carry out a task, and thus the number of cues to use when learning or instructing a pitching technique must be limited. [1]

Since pitching is a movement that involves sequential action of body segments, kinematics in the early preparatory phases are likely linked to kinematics in the latter dynamic phases. Understanding the relationship between kinematics at various time points during pitching would help reduce the number of cues to use in coaching, which may lead to effective instruction.

While pitching involves the interaction of multiple segments, trunk kinematics is central to pitching movement, as the trunk is a critical link between the lower and upper extremities. [2,3] Therefore, the purpose of this study was to examine the relationship between trunk forward flexion, lateral flexion, and rotation angles at stride foot contact (SFC), maximal shoulder external rotation (MER), and ball release (REL).

METHODS

A total of 72 high school baseball pitchers (age: 15.5±1.2 years, height: 1.8±0.1 m, mass: 72.7±9.8 kg, dominance: 56 right/16 left) participated. Pitchers were fitted with reflective markers on significant anatomical landmarks. After warm up, participants pitched (fast pitch) from windup until 3 strike pitches were successfully captured.

The pitch trials were performed from an indoor pitching mound to a backstop that was placed 16.4m away. The pitching mound was instrumented with two force plates (sampling frequency: 900Hz), one underneath the pitching rubber and the other on the slope of the mound. The position of the force plate on the slope was adjusted based the pitcher’s stride length. A seven-camera motion capture system with automatic marker tracking software was used to capture pitching kinematics (sampling frequency: 300fps).

The trunk segment was defined in accordance to the recommendations from the International Society of Biomechanics. [4] The trunk segment angles relative to the global reference frame (+x: anterior, +y: left, +z: vertical) were calculated using an Euler angle sequence of axial rotation, lateral flexion, and flexion. Positive angles indicated axial rotation to the left, lateral flexion to the left, and forward flexion for the right-handed pitcher. For the left-handed pitcher, positive angles indicated axial rotation to the right, lateral flexion to the right, and forward flexion. The angles were identified at SFC, MER, and REL. The instant of SFC was identified from the force plate data, and MER and REL were identified from the kinematic data. Three-trial averages were used for analyses.

Relationships between the trunk kinematic variables were examined using Pearson product-moment correlation coefficients. Correlation coefficients between .25-.5, .5-.75, and above .75 were
considered to indicate fair, moderate to good, and good to excellent relationships, respectively. [5]

RESULTS AND DISCUSSION

At SFC, there were little to no correlations between forward flexion, lateral flexion, and axial rotation angles (r < .25). At MER, greater lateral flexion angle was moderately correlated with smaller rotation angle (r = -.482, p < .001). At REL, greater lateral flexion angle had a good correlation with smaller axial rotation angle (r = -.784, p < .001) and a moderate correlation with smaller forward flexion angle (r = -.719, p < .001). The greater forward flexion angle had a fair correlation with greater axial rotation at REL (r = .469, p < .001).

Moderate correlations were observed between forward flexion angles at SFC and lateral flexion angle at MER (r = .619, p < .001) and REL (r = .527, p < .001). The more forward flexed the trunk was at SFC, the less lateral flexion was present at MER and REL (Figure 2).

The correlation between forward flexion angle at SFC and lateral flexion at MER and REL (Figure 2) demonstrates that the trunk orientation at SFC is linked to the trunk kinematics in the latter dynamic phases. The relationship indicates that trunk orientation in the sagittal plane translates into trunk orientation in the frontal plane, as the pitcher turns 90° to face the hitter.

At REL and between MER and REL, an axial rotation and forward flexion were positively correlated with each other. On the other hand, greater lateral flexion was negatively correlated with axial rotation and forward flexion angles. These observations suggest that forward trunk flexion and trunk rotation are facilitatory to each other, while lateral flexion is inhibitory to forward flexion and axial rotation. This relationship suggests that some pitchers favor the frontal plane trunk movement, while the others favor the transverse and sagittal plane motion.

Understanding the relationship between the trunk kinematics at various time points is important when instructing or learning a pitching technique. Lateral flexion at MER and REL may be manipulated by changing the forward trunk flexion angle at SFC. Similarly, the balance between frontal vs. transverse and sagittal plane trunk movement may be manipulated by changing one of the three trunk rotations. Baseball coaches may utilize the observations from this study to instruct pitchers on their trunk motion.

REFERENCES