QUANTITATIVE ANALYSIS OF THROWING KINEMATICS OF SKELETALLY IMMATURE AND MATURE CATCHERS

Priscilla Dwelly, Hillary Plummer and Gretchen Oliver
University of Arkansas, Fayetteville, AR, USA
email: pdwelly@uark.edu

INTRODUCTION

Despite the immense popularity of baseball and softball, the majority of literature has focused on pitchers while the throwing motion of catchers has been neglected. Only one previous study has examined the throwing motion of catchers when throwing down to second base [1]. It was determined that catchers exhibited less forward trunk tilt at ball release when throwing to second base than pitchers who were observed throwing a similar distance. The authors suggested that catchers have a biomechanically less efficient throwing motion than other players. And suggested this may be due to the reduction in upper trunk rotation and shoulder internal rotation velocities resulting in significantly less ball velocity.

The ability of a catcher to quickly release the ball in order to throw out a base runner attempting to steal is an important skill in both baseball and softball.

Physiologically, overuse injuries are the result of physiological fatigue from repetitive stress and tissue adaptations that ultimately results in mechanical adaptations. With the rise in youth and adolescent throwing injuries, examination of the immature skeleton and its process of maturation are of concern. By understanding torso and upper extremity kinematics in skeletally immature and mature catchers’ pathomechanics may be identified in attempt to prevent injury. Therefore, the purpose of this study was to quantitatively analyze the throwing kinematics of the trunk and shoulder in skeletally immature and mature catchers as they throw down to second base.

METHODS

Forty-six competitively active baseball and softball catchers volunteered to participate. There were no differences between baseball and softball catchers on years of experience or age. All participants had recently completed their competitive season, and were deemed appropriately conditioned for participation and injury free for the past six months. Participants were divided into two categories of skeletally immature and mature. From the 46 participants we selected the youngest 10 participants (10±9 yrs; 144.3±10.3 cm; 38.7±10.8 kg) and described them as skeletally immature and oldest 10 participants (18±2.4 yrs; 169.9±8 cm; 74.9±11.8 kg) and described them as skeletally mature. Participants reported for testing prior to participating in any resistance training or vigorous activity for that day. All testing protocols were approved by the University’s Institutional Review Board.

At the testing facility, participants were prepared so that kinematic data could be collected using The MotionMonitor™ electromagnetic tracking system (Innovative Sports Training, Chicago, IL). Participants had a series of 10 electromagnetic sensors attached at the following locations: (1) the medial aspect of the torso at C7; (2) medial aspect of the pelvis at S1; (3) the distal/posterior aspect of the throwing humerus; (4) the distal/posterior aspect of the throwing forearm; (5) the distal/posterior aspect of the non-throwing humerus; (6) the distal/posterior aspect of the non-throwing forearm; (7) distal/posterior aspect of stride lower leg; (8) distal/posterior aspect of the upper stride leg; (9) distal/posterior aspect of non-stride lower leg; and (10) distal/posterior aspect of non-stride upper leg [3]. Following the attachment of the electromagnetic sensors, an eleventh sensor was attached to a wooden stylus and used to digitize the palpated position of the bony landmarks. A link segment model was developed through digitization of joint centers for the ankle, knee, hip, shoulder, T12-L1, and C7-T1. The spinal column was defined as the digitized space between the associated spinous processes, whereas the ankle and knee were defined as the midpoints of the digitized medial and lateral malleoli, medial and lateral femoral condyles, respectively. By virtue of the least-squares method, [2] the hip and shoulder joint centers were defined.

Participants were given an unlimited time to warm-up. Once participants deemed themselves warm, they were instructed to catch the pitched ball and throw down to second base, simulating a game setting where a runner was trying to steal second. Each participant had five fastballs pitched to them in which they caught and threw down to second base. A position player was on second base and only those throws that he/she was able to catch without stepping off the base was recorded. For the current study, those data form the fastest throw down to second were selected for detailed analysis. Ball velocity was determined by JUGS radar gun (OpticsPlanet, Inc., Northbrook, IL) positioned behind the pitcher and directed towards second base.

Raw data regarding sensor orientation and position were transformed to locally based coordinate systems for each of the respective body segments. Euler angle decomposition sequences were used to describe both the position and orientation of the torso relative to the global coordinate system [4,5]. The use of these rotational sequences allowed the data to...
be described in a manner that most closely represented the clinical definitions for the movements [3].

Data were analyzed with multivariate statistics in the current study using the statistical analysis package PASW 18.0 for Windows (Chicago, IL). $P>0.10$ a priori. Descriptive kinematic data of the trunk and shoulder for the fastest throw to second base were calculated at stride foot contact, maximum external rotation, ball release, and maximum internal rotation.

RESULTS AND DISCUSSION

There were no statistical differences between the two groups on the group of dependent variables ($F[1,17]=55.31, P=0.11$). The two groups graphically displayed similar movements for rotation at the shoulder (Figure 1). However, for elevation and plane of elevation there were slight differences observed, although not statistically significant. The amount of elevation was similar between both groups at the start of the throw, foot contact, and then end of the throw, maximum internal rotation. The skeletally mature catcher however, increased elevation during the cocking phase but during ball release and follow through decreased the amount of elevation. For plane of elevation, the skeletally mature catchers increased the angle of elevation only after ball release, contrary to skeletally mature catchers who horizontally adducted between foot contact and late cocking, and again after ball release.

The two groups displayed similar movements for trunk rotation and lateral flexion (Figure 2). However, for trunk flexion skeletally immature catchers increased flexion during the late cocking phase, then extended back upright compared to skeletally mature catchers who decreased trunk flexion throughout the phases of the throw. These differences were noted on the graph, however not statistically different.

CONCLUSIONS

The current study was able to quantify and describe trunk and shoulder kinematics of throwing down to second in skeletally immature and mature catchers. As this is the only investigation of our knowledge examining skeletally immature and mature catchers, only generalizations were presented. Based on the data presented, the skeletally immature catchers displayed a lack of arm elevation which could be indicative of rushed mechanics. Previously, it has been documented that youth pitchers displayed a rushed delivery and thus implications to injury. More studies need to be conducted in attempt to validate our results as well as more investigation is needed into the injury propensity of these displayed kinematics.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the funding support of the University of Arkansas Women’s Giving Circle.

REFERENCES