INTRODUCTION

Baseball and softball are popular sports in which many athletes choose to participate, and understanding proper throwing mechanics is essential for injury prevention. The throwing mechanics of catchers throwing down to second base have yet to be examined thoroughly in the literature. Catchers have the option of throwing down to second from either their stance or knees in order to throw out a stealing runner. In attempt to improve ball release time many catchers will throw down to second base from their knees. Throwing from the knees eliminates the use of the lower extremity which may affect force transfer up the kinetic chain, possibly resulting in decreased torso rotation and increased shoulder and elbow stress. Improper timing or sequential segment movement while throwing from the knees may place the throwing athlete at an increased risk of injury which may explain the increased occurrence of shoulder injuries in youth. Thus, it was the purpose of this study to examine shoulder and torso kinematics in catchers throwing to second base from their knees.

METHODS

A randomized control trial was implemented in a controlled laboratory setting. Baseball and softball catchers (n=29; 15.2±3.5 years; 165.4±12.8 cm; 66.4±17.2 kg) reported for testing prior to engaging in resistance training or any vigorous activity that day. All of the catchers were right handed. Testing protocols were approved by the University’s Institutional Review Board.

Kinematic and kinetic data were collected using The MotionMonitor™ motion capture system (Innovative Sports Training, Chicago IL) at a rate of 1000Hz. Prior to completing test trials, participants had a series of ten electromagnetic sensors attached at the following locations: (1) the medial aspect of the torso at C7 [1]; (2) medial aspect of the pelvis at S1 [1]; (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 leg femur; (8) distal/posterior aspect of stride leg fibula; (9) distal/posterior aspect of non stride leg femur; and (10) distal/posterior aspect of non stride leg fibula. Sensors were affixed to the skin using double sided tape and secured using flexible hypoallergenic athletic tape. An eleventh sensor was attached to a wooden stylus and used to digitize the palpated position of the bony landmarks. A segment link 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, as the ankle and knee were defined as the midpoints of the digitized malleoli, and femoral condyles, while by virtue of the least-squares method, the hip and shoulder joint centers were defined.

Participants were given an unlimited time to warm-up. Following warm-up participants were instructed to catch a pitched ball and throw down to second base, simulating a game setting where a runner was attempting to steal second base. Each participant had five fastballs pitched to them in which they caught and threw down to second from their knees. A position player covered second base and only those throws that he/she was able to catch without stepping off the base were recorded. 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. Descriptive kinematic data of the trunk and shoulder for the fastest throw to
second base were calculated at the instances of foot contact (FC), maximum external rotation (MER), ball release (BR), and maximum internal rotation (MIR).

RESULTS AND DISCUSSION
Trunk and shoulder kinematics are depicted in Figure 1. As catchers throw from their knees, the amount of trunk flexion present is greatest at maximum external rotation and decreases until they are in an upright position at maximum internal rotation. At foot contact the trunk is positioned flexed toward the right and then gradually flexes to the left throughout the throwing motion where it finally reaches its greatest value at maximum internal rotation. Trunk axial rotation was greatest at foot contact, the point at which the catcher attempted to rotate towards second base. Shoulder plane of elevation displayed slight extension at MER and then moved into forward flexion at BR and on into MIR. Shoulder elevation, or abduction of the humerus, gradually increased from the start of the motion until reaching a mean maximal angle of 88° at the point of maximum external rotation. It is interesting to note, that when throwing from the knees, catchers do not reach the optimal shoulder elevation of 90°. Following the peak of shoulder elevation, at maximum external rotation, the elevation of the shoulder then decreases. The shoulder is in an externally rotated position at foot contact and continues to externally rotate until it reached MER.

CONCLUSIONS
This study successfully described the kinematics of throwing from the knees in catchers. Understanding the kinematics of throwing can lead to the identification of potentially harmful pathomechanics in catchers. The inability for catcher to reach optimal shoulder elevation may lead to additional stresses being placed on the shoulder and elbow and eventually cause injury. To our knowledge, this is the first study to examine the kinematics of catchers throwing from their knees and more studies are needed to validate our results. Future research should be directed towards determining how the throwing mechanics of catchers relates to the kinematics observed in baseball pitchers.

REFERENCES

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Figure 1. Trunk and shoulder kinematic variables at each event mark.

Trunk flexion (-) is flexion; Trunk lateral flexion (+) is to the right for a right handed thrower. Trunk axial rotation (-) is to the right; Shoulder plane of elevation 0= abduction and 90=forward flexion; shoulder elevation 0=full abduction while -90 = 90 degrees abduction; and shoulder rotation (+) is internal rotation while (-) is external rotation.