COMPARISON OF THE CATCHER'S TRADITIONAL THROW-DOWN VERSUS PITCH-OUT

James Chen[1] and Heng-Ju Lee [2]
[1] Department of Athletic Performance, National Taiwan Normal University, Taiwan
[2] Department of Physical Education, National Taiwan Normal University, Taiwan

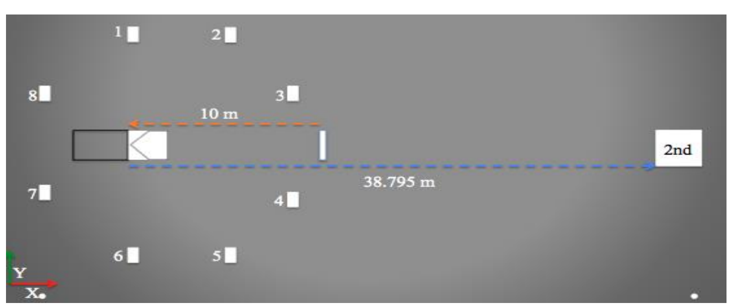
The catcher is often the defensive leader on the field. With a plethora of assignments to manage during a game, one of the many responsibilities a catcher has is catching base runners that attempt to steal. Catchers throwing out base stealers at second base utilize two methodologies: a traditional throw-down or the pitch-out. The purpose of the study was to explore potential differences in joint kinematics between the two motions when throwing to second base and how performance is affected. Vicon cameras recorded the throwing motions of the catcher, providing data for kinematic analysis. The pitch-out showed higher ball velocities than the traditional throw-down, but similar pop times. Furthermore, elbow extension and trunk angular velocities were significantly different. With knowledge of the throwing kinematics of catchers, performance can be potentially improved and injury avoided.

KEYWORDS: throwing mechanics, joint kinematics, baseball

INTRODUCTION: In the game of baseball, nine players take the field to defend against an offense that can easily score once runners are on base. The battery, pitcher and catcher, manage the defensive rhythm of the game in order to thwart the runner from advancing to another base by means of stealing. From a defensive standpoint, the catcher is an imperative position in a baseball game. With this notion, the throwing motion and performance of the catcher is analyzed. Due to the distance between home plate and second base being greater than home plate to first or third base, 38.8 meters and 27.4 meters respectively, the majority of base-stealing can be seen between first and second base, with runners more likely to score from second than from first (Sheehan, 2004).

The catcher has the responsibility of foiling any base-stealing attempt along the base paths (Bail, 2005). In order to catch a runner attempting to steal second base, the catcher must first catch the ball thrown by the pitcher and transfer the ball "cleanly" and smoothly into the throwing hand (Plummer & Oliver, 2013). Prior to this phase, the catcher has already determined which throwing motion to use to throw down to second base. A traditional throw-down would involve the catcher catching the ball while turning his/her body perpendicular to second base, with the lead foot pointing at second base. Once the body is turned, the catcher's arm is cocked and proceeds with the throwing motion towards second base. If the catcher predetermines that a pitch-out will be necessary to catch a base-stealer, the catcher will stand up from the crouched position, side step away from the batter's box to receive the pitch, and proceed to transfer the ball to the throwing hand and throwing the ball to second base. It is assumed amongst players and coaches that the pitch-out would be the quickest method to throw-out a base runner attempting to steal second base. However, if the pitch-out is executed, a ball is called and an unfavorable count results. In addition to investigating the kinematics of the catcher using these two throwing motions, the performance aspect will also be scrutinized to determine which methodology is in fact the quickest.

METHOD: Vicon's T-Series Motion Capture system (*Vicon Motion Systems Ltd. UK)* recording at 250 Hz captured the throwing motions of eleven catchers. The catcher's area, including home plate, was at the



center of the surrounding Vicon cameras, while a pitcher's throwing area was 10 meters away from home plate. A research assistant stood at second base to catch the ball thrown by the catcher, 38.8 meters away. Regulation size and mass baseballs were used during the study. Forty-eight reflective skin markers were placed on the test participants to create the 3D model. In addition, three strips of reflective material were taped onto the surface of the ball to allow the ball to be seen by the cameras.

The eleven professional, male catchers were all healthy and had no injuries in six months prior to the voluntary participation in the study (Age: 25.6 ± 2.2 years; height: 174 ± 5.1 cm; mass: 82 ± 9.3 kg; baseball experience: 14.7 ± 2.3 years). Trials for both the traditional throw-down and pitch-out were conducted with the order randomly assigned for each catcher. The catchers were allowed their normal warm up routine prior to the testing sessions. Each catcher was instructed to simulate game scenarios (runner at first attempting to steal second) and throw the ball as accurately and as fast as possible to second base. The catchers needed to complete each throwing motion successfully three times. Success was defined as: catching the ball and smoothly transfer the ball to the throwing hand, take one step and throw, with the ball in catchable range at second base. The performance factors of ball velocity, pop time (time frame of ball being caught by the catcher and released from throwing hand), and the amount of time for the ball to travel to second base were compared for the two throwing motions. Additionally, joint kinematics analysis was conducted. Mean and standard deviation was calculated for joint kinematics and performance measurements. Repeated measures and regression provided statistical analysis for the joint kinematic factors that potentially influence the performance outcomes, with the α level set at 0.05. All statistical analysis was processed with Statistical Package for Social Sciences (SPSS) version 20.0.

RESULTS & DISCUSSION: Significant differences were seen in angular velocities and performance results between the two throws. The traditional throw-down had slower ball velocities, pop time, and time to second base in comparison to the pitch-out, as seen in Table 1.

Table 1.Performance results for traditional throw-down and pitch-out (values are mean±SD (n=11)).

	Traditional Throw-down	Pitch-out	
	Mean	Mean	p value
Ball velocity (m/s)	29.91±2.80	31.42±2.56	0.024*
Pop time (s)	0.79±0.07	0.77±0.11	0.515
Time to second base (s)	1.31±0.12	1.24±0.11	0.021*
Stride length (m)	1.22±0.11	1.20±0.11	0.117

*Significant differences, p<0.05

Joint kinematics analysis revealed that shoulder abduction, external rotation, trunk angular velocity, and trunk lateral tilt significantly affected the ball velocity for the traditional throw-down. The pitch-out's pop time was positively influenced by the shoulder external rotation and trunk lateral tilt angles. There were no significant differences for shoulder external rotation, abduction, and extension, however showed significant differences in the shoulder's extension. Trunk lateral tilt angles displayed differences between the two throwing motions, yet none were seen in the trunk's extension and forward tilt. Angular velocities for the elbow's extension, shoulder's internal rotation, and trunk's rotation were also calculated, with only elbow extension and trunk angular velocities displaying significant differences, p-values 0.04, 0.022 respectively.

Table 2. – Joint Kinematics for traditional throw- down and pitch-out (values are mean±SD (n=11)).

	Traditional Throw-down	Pitch-out	
	Mean	Mean	p-value
Elbow Extension (degree/s)	2047.40±219.51	2007.28±202.91	0.04*
Trunk (degree/s)	300.84±39.32	288.75±44.47	0.022*
Shoulder Internal Rotation (degree/s)	1063.43±188.83	1032.09±201.63	0.141
Trunk Lateral Tilt (degrees)	19.67±5.41	18.33±5.22	0.011*
Trunk Forward Tilt (degrees)	6.49±4.26	6.02±4.80	0.554
Shoulder External Rotation (degrees)	138.41±12.79	137.46±11.87	0.129

*Significant differences, $p<0.05$

Revelations about the elbow, shoulder and trunk angles could potentially increase performance outcomes. For instance, extending the elbow and rotating the trunk faster could possibly be a way for the catcher to generate more throwing power from the traditional throw-down position, in order to compensate for a more stationary movement. Since the pitch-out has momentum shifting towards second base, it is likely that additional trunk rotation and elbow extension is necessary to generate faster ball velocities. Although several factors influence ball velocity and pop time, reduction in potential negative influences such as raising the arm too high, leaning the trunk too far back, or not externally rotating the arm enough can undoubtedly boost performance results in some respect. If ball velocity can be increased, thus decreasing the time needed for the ball to travel to second base, the chances of catching a base runner would drastically increase. Decreasing the pop time also improves the possibility of succeeding in catching a base runner stealing.

Trying to tweak technique to increase performance could possibly pose a risk of injury for the catchers. Research conducted by Baker and Ayers in 2004 found that as the throwing arm is externally rotated and abducted further backwards, the ball will travel faster. The maximum shoulder external rotation additionally allows the shoulder to generate more stretch reflex while allowing the muscles more time to add force due to the greater angle range in the shoulder (Matsuo et. al, 2001). However, if the external rotation angle is increased to such a large degree when trying to gain additional power, the shoulder muscles stretch even further, thus potentially could lead to the shoulder sustaining microtraumas (Park et al., 2002). Fleisig and fellow researchers in 2011 proposed that plausible reasons for symptoms of shoulder internal impingement could be due to excessive external rotation when the shoulder is abducted. By knowing the inherent implications for injury and technical adjustments for throwing, performance results can potentially be improved, rehabilitation be thoroughly performed and harmful motions be avoided, while reduce the risk for injury.

CONCLUSION: Baseball is a game measured in mere inches and seconds that could mean the difference between a win or a loss. A runner can be ruled safe or out by the slightest of margins. In order to increase the catchers' probability of successfully thwarting a base-stealing attempt, they must be coached and advised on how to improve their technique while minimizing the chances of injury. Through the use of 3D motion technology, ideal throwing mechanics can be provided to the coaches. Furthermore, the assumption that the pitch-out is quicker than the traditional throw-down was validated by the research. By means of the research, it is possible to see the tendencies of the catchers, what potentially affects their performance, and how to refine their technique.

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