The Corinthian

Volume 17 Article 6

2016

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Abstract

Research has been completed discussing flexibility and throwing velocity, but there is a void of literature determining whether these two variables are related.
Purpose: The purpose of this study was to determine if there is a correlation between the flexibility of the glenohumeral joint and the throwing velocity of a baseball.
Methods: Thirty college males, all above the age of 18 years of age, volunteered to throw a baseball as fast as they could, having three separate trials to reach their maximal throwing velocity. The participants completed the "Back Scratch" test to assess the flexibility of the glenohumeral joint in each arm. Each participant completed three throwing trials and the velocities were recorded into a chart along with their back scratch test results and hand dominance. A Pearson Product-Moment Correlation Analysis was performed to determine if a correlation between glenohumeral joint and the throwing velocity of a baseball existed. An independent t-test was also conducted to determine if there was a difference between hand dominance and glenohumeral joint flexibility. Significance was accepted at $p<0.05$
Results: It was found that there was no correlation between glenohumeral joint flexibility and average throwing velocity. Left-hand dominant participants had a mean flexibility of 1.3±1.9 inches in the left arm and 2.1±1.9 inches in the right arm. They had an average throwing velocity of 83.2±6.0 mph. Right-hand dominant participants had a mean flexibility of -1.7±2.9 inches in the left arm and 0.5±2.4 inches in the right arm. They had average mean velocity of 77.9±9.9 mph. There was significant difference in left arm

and beneficial for athletes to stretch before performance (Haag, Wright, Gillette, & Greany, 2010; Williams, Harveson, Melton, Delobel, 2013). Haag, et. al, found that static stretching did not affect pitching speed and pitching hitting statistically for baseball players. Williams and his team of researchers found that when his participants performed static stretching prior to performance, their average throwing velocity was statistically significant in throwing at greater velocities (Williams, Harveson, Melton, Delobel, & Puentedura, 2013). Simic and Markovic found from their research that static stretching during a warm up routine should be avoided before participating in athletic sports (Simic & Markovic, 2012). Their study suggests that static stretching has a negative effect on throwing velocity, performance, and strength. Although there are several research studies that independently discuss flexibility, static and dynamic stretching, and throwing velocity in baseball, there are no research studies that correlate flexibility and throwing velocity. In addition, since there is disagreement about the importance of stretching, which leads to flexibility, it is important to know if flexibility can hinder or benefit athletic performance. To date, there is no research investigating the correlation between glenohumeral flexibility and throwing velocity. Therefore, the purpose of the present study is to determine the correlation between the flexibility of the glenohumeral joint and the throwing velocity of a baseball. It is believed that there will be a positive correlation between flexibility of the glenohumeral joint and the throwing velocity of a baseball. The results from the research may be used to advocate the implementation and or enhancement of flexibility programs in throwing sports in order to enhance athletic performance.

Methods

Overview of the Study

College-aged males ranging from 18-22 years of age were recruited to participate in this study, which involved having their flexibility measured and their baseball throwing velocity assessed. The participants began their warm up by walking or jogging around the

measure the distance between the tips of the middle finger. If the individual's fingertips touched, then the score was zero. If the fingertips overlapped, then the score was assessed as a positive difference of the fingertip overlap distance. If the fingertips did not meet, then the score was assessed as a negative difference of the fingertip gap distance. The distance was measured to the nearest tenth of an inch by a flexible tape measure. Participants then proceeded onto a flat surface where they warmed up by throwing a baseball. The participants were provided three baseballs to throw during the warm up and final throwing velocity trials. The participants were given three warm up throws each at 20 feet and 40 feet. The three baseballs were returned to the participant after throwing at each marked area. For the recorded throws, one of researchers stood on the opposite end of the field with the Baseball Pitch Speed application (found in the iTunes store), which calculated the velocity of the baseball. The researcher who held the radar device stood behind an L-net baseball screen while the ball was being thrown to ensure their safety. For the throwing velocity trials, participants were positioned at the sixty-foot mark and given three trials to reach their maximum throwing velocity. The data collected from each individual was recorded onto a data sheet that consisted of flexibility measurements, each of the individual throwing trials at the sixty-foot length, and the average of the three throwing trials.

Statistical Analysis

All of the data collected was analyzed using the Statistical Package for the Social Sciences software. A Pearson Correlation Analysis was conducted to determine whether there was a correlation between glenohumeral joint flexibility and throwing velocity of a baseball. In addition, an independent t-test was conducted to determine if there was a difference between left and right hand dominance as it related to right glenohumeral joint flexibility. For all analyses, the alpha level was set at $\alpha = 0.05$ with a 95% confidence interval.

inches and 0.5±2.4 inches in the right arm. Left-handed dominant participants were significantly (p= 0.005) more flexible in their left arm (1.3±1.9 inches) compared to right-handed dominant participants (-1.7±2.9 inches). Left-handed dominant participants did not show significance (p=0.076) for being more flexible in their right arm (2.1±1.9 inches) compared to right handed-dominant participants (0.5±2.4 inches). See **Figure 2** for results of flexibility between left-and-right handed dominance.

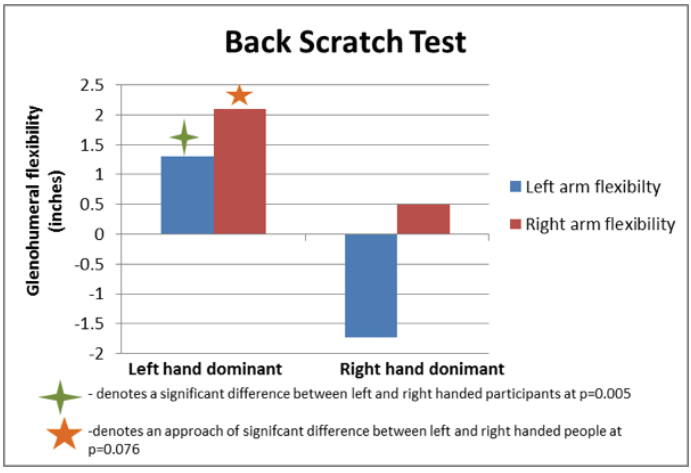

Figure 2: Left and right arm flexibility in left and right hand dominant participants (N=30).

Discussion

The main purpose of this study was to determine if the glenohumeral joint flexibility was associated with baseball throwing velocity. It was hypothesized that these two variables would have a positive correlation. From the results that were collected, we failed to reject the null hypotheses that there was a positive correlation between glenohumeral joint flexibility and baseball throwing velocity. Thus, it was concluded that there is no relationship between glenohumeral joint flexibility and throwing velocity of a baseball. Although there are several studies that independently discuss glenohumeral joint flexibility and throwing velocity, there are no

size would be more beneficial for a correlational study and possibly improve the chance at finding significant analyses. Inter-individual variability presents another limitation in the study. The levels of athletic ability among the participants in the study varied greatly. The athletic ability differences within the study could have affected the data, causing miscalculations of throwing velocity. Some participants did not possess proper throwing mechanics, which could cause their throwing velocity to be different from what it would be if they did have proper throwing mechanics. The data could also be affected due to the skill level of participants regarding throwing mechanics. Fleisig, Chu, Weber, and Andrews found in their study that high school baseball pitchers have less variation than youth pitchers (2009). Even though our participants were in the same age category, they had a wide range of athletic ability from never having played baseball to collegiate level baseball players. The biomechanics of each participant can also be different due to shoulder impingement and other injuries. No injury history was recorded for each participant for the study. Present or past injuries can change the velocity, shoulder flexibility, and direction of the object being thrown causing a limitation in the study. In a previous study that assessed differences between the dominant and non-dominant limbs, it was found that adaptations to injury affect the individual's mobility (Baltaci and Tunay, 2004). Therefore, the data collected in the current study could truly be affected by not being aware of possible adaptations the participant may have gained from an injury.

Although we failed to reject the null hypothesis regarding the relationship between glenohumeral flexibility and baseball throwing velocity, there are significant findings that can be taken away from the study. Since the data collected found that flexibility and throwing velocity have no relationship, coaches should not focus on flexibility with the intent of improving the throwing velocity of the ball. Even though the data shows no significant correlation between glenohumeral joint flexibility and throwing velocity, the results that were found can still be applied. The data collected can be referenced for a study that may look at the differences in right and left handed individuals regarding flexibility. After reviewing the results of the study, future research should focus on the biome-

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flexibility between the left and right hand dominant participants (p=0.005). A difference in right arm flexibility was not significant between left and right hand dominant participants (p=0.076). *Conclusion:* There was no correlation found between glenohumeral joint flexibility and average throwing velocity. According to these results, coaches should not focus on making their athletes more flexible in hopes to gain a higher throwing velocity.

Introduction

"Never let the fear of striking out keep you from playing the game."
-Babe Ruth

Since 1869 there have been minor changes to the rules of baseball, but the factors of the game have evolved. In the game of baseball, there are many factors that influence the velocity of a ball being thrown. These factors include arm angle, wrist action and speed, rotation, balance, arm speed, unison of forces, and full mechanics (Bagonzi, 2001). A factor that is not regularly mentioned is flexibility. Many non-professionals assume that arm strength plays a major role in throwing velocity. Reports find this information to be false, stating that throwing velocity is created before the arm starts to accelerate (Nave, 2014). Future studies may have found a relationship between a baseball pitcher's durability, consistency, and velocity of throwing a baseball. In a study performed by Seroyer and his team of researchers, a conclusion was formed that a pitcher's velocity may have a relationship with kinematic factors, along with specific body motions (Seroyer, Nho, Bach, Bush-Joseph, Nicholson, & Romeo, 2010). When the arm is accelerating forward, there is little muscle activation in the shoulder muscles. Velocity comes from the elastic energy from the thrower's arm in the cocked position, the "whipping" motion at the last second before the ball is released. Elastic potential energy is potential energy stored as a result of deformation of an elastic object, such as the stretching of a spring (Strooden, Fleisig, Scott, & James, 2005). The elastic energy comes from the flexibility of the glenohumeral ligaments, tendons, and isometric contracted muscles.

There is a disagreement concerning whether or not it is safe

intramural field at Georgia College & State University (GCSU) and then performed dynamic stretching of their glenohumeral joint. The individuals then participated in the back scratch test and their results were recorded. Then, they were given multiple warm up trials that included throwing the baseball ball at different lengths. The final throwing velocity, at the sixty-foot mark, was measured with a radar gun, recording the three throwing results for each individual.

Subjects

Participants were recruited from the GCSU campus through public advertisement. Flyers were posted in the GCSU Wellness and Recreation Center and at the Ina Dillard Russell Library. The flyer requested the participation of male individuals. Once the participants expressed interest, each completed an informed consent document to inform them of the procedures and possible benefits and risks from participation.

Procedures and Data Collection

Once each participant agreed to the terms of the study and signed the informed consent document, they were assigned a number so that their confidentiality was maintained during the data collection process. Participants met at the GCSU Intramural Fields for data collection. First, the participants were instructed to warm up by walking or jogging one lap around the intramural fields. Next, the participants performed forward and backward arm circles for 10 seconds. Then, the individual's shoulder flexibility and range of motion were assessed via the "Back Scratch" test (Jones and Rikli, 2002). To perform the back scratch test, the individual stood straight up and then proceeded to place one hand behind their head and back over the shoulder, with their palm touching their body. They then proceeded to reach as far down their back as possible. Their other arm was then placed behind their back with their palm facing out and reached as far as possible upward. The goal of the "Back Scratch" test was to overlap the middle fingers. The fingers should be aligned in order for the test instructor to

Results

Thirty male participants volunteered for this study. Of the thirty participants, 66% (n=20) of the males were collegiate athletes, and 34% (n=10) of the males were non-athletes. Of the participants, 66% (n=20) were right hand dominant and 34% (n=10) of the participants were left hand dominant. An independent t-test and a Pearson correlation analysis were utilized to analyze the data. It was determined that there was no correlation between the flexibility in the right glenohumeral joint and the average throwing velocity ($r=0.19$, $p=0.31$) nor was there a correlation in the flexibility in the left glenohumeral joint and the average throwing velocity ($r=0.13$, $p=0.48$). Left and right hand dominance were not significantly different regarding average throwing velocity. The average throwing velocity of participants that were left-hand dominant was 83.2±6.0 mph. Right hand dominant participants showed an average throwing velocity of 77.9±9.9 mph. See **Figure 1** for a report on average throwing velocity among the participants.

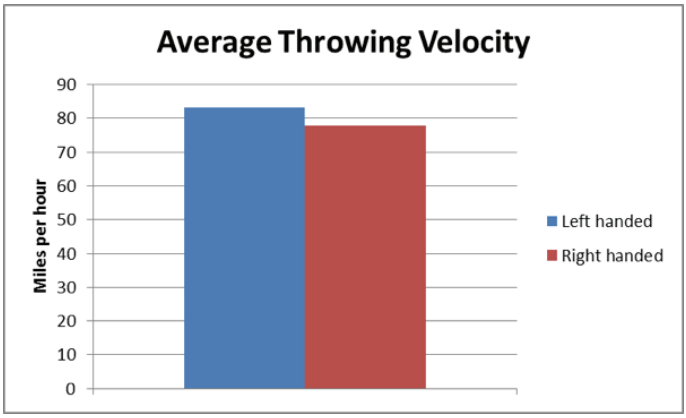

Figure 1: Average velocity for left and right hand dominant participants (N=30).

The study found that the left-handed dominant participants had a mean flexibility of 1.3± 1.9 inches in the left arm and a mean flexibility of 2.1±1.9 inches in the right arm. In right-handed dominant participants, the mean flexibility of their left arm was -1.7±2.9

studies discussing the correlation between the two variables, glenohumeral joint flexibility and throwing velocity to which the results of the present study can be compared.

The variable of flexibility is the most underestimated component of the game of baseball. Since throwing a baseball requires many mobile joints, flexibility plays a significant role in the throwing mechanics. The most mobile joint in the body is the glenohumeral joint. The shoulder is a ball-and-socket joint and the ball of the shoulder fits loosely into the socket. The farther a baseball player is able to extend the glenohumeral joint back in external rotation with no restriction, the better the baseball player will be able to use his arm like a whip (Seroyer, Nho, Bach, Bush-Joseph, Nicholson, & Romeo, 2010). Flexibility is critical in preventing the individual from injury. A flexible glenohumeral joint will allow the baseball player to transfer all of the energy generated in the leg drive up through the trunk and out the arm (Seroyer, et al., 2010). Velocity is the other main component in baseball. Even though it is a main component, it is not as significant in the sport as flexibility. Velocities are different for every position on the field, from the left fielder to the pitcher. Every position will have completely different velocities. For example, a second basemen might not have the highest velocity when throwing, but his position does not require him to throw at maximum velocity.

Significant differences were observed between right and left hand dominance for left shoulder flexibility. Left-handed dominant participants showed significantly greater left shoulder flexibility than right hand dominant participants. Left-handed dominant participants had right shoulder flexibility that was approaching significance for being more flexible than right hand dominant participants. There are no previous sport studies that used the "Back-Scratch" test as a means of measuring glenohumeral flexibility; however, past studies have found similar results to the present study regarding flexibility and hand dominance. Specifically, Bigliani, et al., found that flexibility is significantly greater in the dominant side of the body in professional baseball players (Bigliani et al., 1997).

There are several limitations in the present study. The sample size of the study included 30 participants. A larger sample

chanics and the kinetic chain when throwing a baseball. Seroyer and colleagues state, "A pitcher's velocity, consistency, and durability may be linked to kinematic and kinetic factors as well as the temporal association of segmental body motions" (Seroyer, Nho, Bach, Bush-Joseph, Nicholson, & Romeo, 2010). After reviewing this article and completing the present study, it may be beneficial to study the correlation between full body flexibility, injuries within the body, and throwing velocity.

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