Internet Journal of Allied Health Sciences and Practice

Volume 22 | Number 1 Article 6

December 2023

Effects of a Dynamic Arm Stabilizer on Varus Elbow Torque, Arm Speed, and Velocity in Collegiate Baseball Players: A Pilot Study

Andrew Cage
The University of Texas at Tyler, scage@uttyler.edu

Laurel Trail
The University of Texas, ltrail@uttyler.edu

Lynzi Warner
Creighton University, lynziwarner@creighton.edu

Brandon J. Warner
Grand Canyon University, brandon.warner@gcu.edu

Recommended Citation

Cage A, Trail L, Warner L, Warner BJ. Effects of a Dynamic Arm Stabilizer on Varus Elbow Torque, Arm Speed, and Velocity in Collegiate Baseball Players: A Pilot Study. The Internet Journal of Allied Health Sciences and Practice. 2023 Dec 15;22(1), Article 6.

Effects of a Dynamic Arm Stabilizer on Varus Elbow Torque, Arm Speed, and Velocity in Collegiate Baseball Players: A Pilot Study

Abstract

Purpose: The purpose of this study was to assess the effect a dynamic arm stabilizer had on varus elbow torque, arm speed, and throw velocity during baseball throwing. **Methods:** 8 collegiate baseball players (age= 20 ± 1 years, height= 183.5 ± 6.5 cm, weight= 85.6 ± 7.7 kg) participated in this study. Participants were randomly assigned to throw their first set of 25 throws at 90 feet wearing a dynamic arm stabilizer or throw their second set of 25 throws at 90 feet not wearing a dynamic arm stabilizer. After completing the first set of throws, the participants threw a second set of 25 throws at 90 feet in the opposite condition. Elbow varus torque and arm speed were measured using a wearable inertial measurement unit, and throwing velocity was measured in miles per hour using a handheld radar gun. Pearson's correlations were performed to determine relationships between varus torque, arm speed, and velocity during activity with and without the dynamic arm stabilizer. Then, paired samples t-tests were performed to determine differences between varus torque, arm speed, and velocity with and without the dynamic arm stabilizer. **Results:** Significant correlations were found between varus torque and arm speed, varus torque and velocity, and arm speed and velocity when wearing the dynamic arm stabilizer. Other correlations found were between varus torque and velocity, and arm speed and velocity when not wearing the dynamic arm stabilizer. Significant differences were found between throwing with the dynamic arm stabilizer and not wearing the dynamic arm stabilizer in varus torque (stabilizer = 45.80 ± 8.12 Nm, no stabilizer = 51.85 ± 8.87 Nm, $p < .001$), arm speed (stabilizer = 857.39 ± 59.64 degrees per second, no stabilizer = 876.58 ± 82.74 degrees per second, $p < .001$), and throwing velocity (stabilizer = 70.95 ± 5.21 mph, no stabilizer = 71.77 ± 5.68 mph, $p < .001$). **Conclusions:** Use of a dynamic arm stabilizer results in a decrease in varus elbow torque when throwing on flat ground at 90 feet. The dynamic arm stabilizer also resulted in a decrease in arm speed and throwing velocity when compared to throwing without a dynamic arm stabilizer. Further research is needed to determine the clinical meaningfulness of these findings in order to determine the best application for a dynamic arm stabilizer in baseball players.

Author Bio(s)

S. Andrew Cage, EdD, LAT, ATC, is the Head Athletic Trainer at The University of Texas at Tyler. He is also a licensed athletic trainer in the state of Texas.

Laurel E. Trail, MPA, LAT, ATC, is the Assistant Athletic Trainer at The University of Texas at Tyler. She is also a licensed athletic trainer in the state of Texas.

Lynzi Warner, MSPAS, PA-C, LAT, ATC, is an Assistant Professor at Creighton University. She is also a certified physician assistant in the state of Arizona.

Brandon Warner, M.Ed., LAT, ATC, is the Athletic Training Program Director at Grand Canyon University. He is also a licensed athletic trainer in the state of Arizona.

The Internet Journal of Allied Health Sciences and Practice
Dedicated to allied health professional practice and education
Vol. 22 No. 1 ISSN 1540-580X

Effects of a Dynamic Arm Stabilizer on Varus Elbow Torque, Arm Speed, and Velocity in Collegiate Baseball Players: A Pilot Study

Andrew Cage[1]
Laurel Trail[1]
Lynzi Warner[2]
Brandon J. Warner[3]

1. University of Texas
2. Creighton University
3. Grand Canyon University

United States

ABSTRACT
Purpose: The purpose of this study was to assess the effect a dynamic arm stabilizer had on varus elbow torque, arm speed, and throw velocity during baseball throwing. **Methods:** 8 collegiate baseball players (age= 20 ± 1 years, height= 183.5 ± 6.5 cm, weight= 85.6 ± 7.7 kg) participated in this study. Participants were randomly assigned to throw their first set of 25 throws at 90 feet wearing a dynamic arm stabilizer or throw their second set of 25 throws at 90 feet not wearing a dynamic arm stabilizer. After completing the first set of throws, the participants threw a second set of 25 throws at 90 feet in the opposite condition. Elbow varus torque and arm speed were measured using a wearable inertial measurement unit, and throwing velocity was measured in miles per hour using a handheld radar gun. Pearson's correlations were performed to determine relationships between varus torque, arm speed, and velocity during activity with and without the dynamic arm stabilizer. Then, paired samples t-tests were performed to determine differences between varus torque, arm speed, and velocity with and without the dynamic arm stabilizer. **Results:** Significant correlations were found between varus torque and arm speed, varus torque and velocity, and arm speed and velocity when wearing the dynamic arm stabilizer. Other correlations found were between varus torque and velocity, and arm speed and velocity when not wearing the dynamic arm stabilizer. Significant differences were found between throwing with the dynamic arm stabilizer and not wearing the dynamic arm stabilizer in varus torque (stabilizer = 45.80 ± 8.12 Nm, no stabilizer = 51.85 ± 8.87 Nm, $p < .001$), arm speed (stabilizer = 857.39 ± 59.64 degrees per second, no stabilizer = 876.58 ± 82.74 degrees per second, $p < .001$), and throwing velocity (stabilizer = 70.95 ± 5.21 mph, no stabilizer = 71.77 ± 5.68 mph, $p < .001$). **Conclusions:** Use of a dynamic arm stabilizer results in a decrease in varus elbow torque when throwing on flat ground at 90 feet. The dynamic arm stabilizer also resulted in a decrease in arm speed and throwing velocity when compared to throwing without a dynamic arm stabilizer. Further research is needed to determine the clinical meaningfulness of these findings in order to determine the best application for a dynamic arm stabilizer in baseball players.

Key Words: baseball, overhead throwing, prevention

INTRODUCTION

Despite efforts to curb the growing prevalence of shoulder and elbow injuries in baseball pitchers, injury rates continue to rise.[1-3] In fact, it has been reported that over one quarter of youth pitchers will report elbow pain over the course of two seasons of throwing.[4] Additionally, half of youth pitchers report shoulder pain over the course of one season of pitching.[5] This is not a new problem in baseball. In 1973, Tullos and King reported that as many as 50% of pitchers playing at the professional level will experience elbow or shoulder pain at some point in their career.[6] The authors used being unable to throw as their metric for the pain described in their study.[6] When collegiate and professional pitchers sustain shoulder and elbow injury, there is also stress from the potential for lost future financial compensation. This financial concern can become problematic for future pitchers, especially when future compensation is impacted.[7]

Injuries to the ulnar collateral ligament of the elbow can be particularly confounding when examining methods of injury prevention in baseball pitchers. As previously mentioned, over one quarter of youth pitchers deal with elbow pain during the course of two seasons of pitching.[4] The majority of this elbow pain has been associated with the ulnar collateral ligament (UCL).[4,8] When assessing the tensile strength of the UCL, McGraw et al found the UCL could undergo approximately 35 Nm of valgus force before structural failure in an in-vitro setting.[9] The findings of this study appear to be in conflict with the findings of in-vivo studies of baseball pitchers that found peak external valgus force at the UCL to be between 45 and 120 Nm of force during the late cocking and acceleration phases of the baseball pitching motion.[10,11] A possible explanation for the difference in tensile strength when comparing in-vitro and in-vivo studies is that in-vitro studies do not take into account other dynamic stabilizers.[8] Muscles responsible for wrist flexion and pronation have the potential to resist valgus forces directly, and the muscles responsible for elbow flexion and extension appear to have an indirect role in resisting valgus force at the elbow.[8] As such, adequate dynamic stabilization of the elbow may play a role in decreasing risk of injury when pitching in baseball.

While the financial implications of injury are important, surgery and long-term rehabilitation may also have a negative impact on throwing mechanics and pitching performance.[12] Based off these considerations, decreasing the prevalence of shoulder and elbow injuries has been the focus of multiple studies and innovations.[13-15] One such device that has been created to decrease the risk of injury when pitching is a dynamic arm stabilizer known as the Kinetic Arm™ (The Kinetic Arm™, The Perfect Arm, LLC, Chamblee Georgia).[16]

The Kinetic Arm™ aims to decrease torque at the elbow and shoulder during throwing and pitching through a patented bio-web design.[16] Through this design, the stabilizer is intended to increase external support at the humeroulnar and glenohumeral joints.[16] To date, there appears to be know studies examining the effectiveness of a dynamic arm stabilizer for decreasing varus torque at the elbow during baseball pitching and throwing. Therefore, the purpose of this study was to assess the effect a dynamic arm stabilizer had on varus elbow torque, arm speed, and throw velocity during baseball throwing.

METHODS

Participants

A total of eight apparently healthy collegiate baseball pitchers consented to and participated in this study as a convenience sample (age= 20 ± 1 years, height= 183.5 ± 6.5 cm, weight= 85.6 ± 7.7 kg). All participants were informed of the study's purpose, and informed consent was obtained. Participants were randomly assigned to a group using a random number generator. One group threw the first set of throws wearing the dynamic arm stabilizer, and the other group wore the dynamic arm stabilizer during the second set of throws.

Elbow Varus Torque, Arm Speed, and Throw Velocity

Elbow varus torque and arm speed were measured using a wearable inertial measurement unit (DriveLine Pulse, DriveLine Baseball, Kent, WA) shown in Figure 1. The model of inertial measurement unit was chosen based on previous use in peer reviewed research.[13-15] Another factor in choosing this model was the documented consistency in measurements.[15,17]

Prior to placement of the inertial measurement unit, the subject's height and weight was input into the smart phone-based software interacting with the unit. The inertial measurement unit was placed in a neoprene strap designed by the manufacturer. The unit was positioned 1.5 inches inferior to the medial epicondyle of the humerus. Once placed properly, the strap was secured using Velcro. Measurements of elbow varus torque in Nm and arm speed degrees per second were taken real time using a Bluetooth interface and a smart phone.

Figure 1. DriveLine Pulse, DriveLine Baseball (Kent, WA)

Throwing velocity was measured using a handheld radar gun (Stalker Pro II, Stalker Sport, Richardson, TX). An investigator stood behind the participant during throwing and measured throwing velocity real time in miles per hour.

Dynamic Arm Stabilizer

The Kinetic Arm™ was chosen for the project, as it appears to be the only such device commercially available. Prior to being instructed on how to don the device, participants' biceps and chest circumference was measured in inches to allow the research team to select the proper size. Subjects were then instructed on how to wear the device. Once the device was on the patients, the device was tightened by the research team to ensure that it was as tight as comfortably possible.

Experimental Procedures

Prior to throwing at 90 feet and data collection, participants were instructed to take as long as they need to warm up and prepare to throw. Participants assigned to the first group wore the dynamic arm stabilizer during warm up throwing as shown in Figure 2. Participants assigned to the second group donned the dynamic arm stabilizer prior to their second set of throws. All participants threw two sets of 25 throws at 90 feet and wore the dynamic arm stabilizer for one set and did not wear it for the second set. Measures of varus elbow torque, arm speed, and velocity were taken for all 50 throws.

Figure 2. Throwing Posture of Participants

Statistical Analysis

A commercially available statistical software package was used to perform all analyses (SPSS V28, IBM, Armonk, NY). Means and standard deviations were calculated to describe demographic information about the participants. Pearson's correlations were performed to determine relationships between varus torque, arm speed, and velocity with and without the dynamic arm stabilizer. Paired samples t-tests were performed to determine differences between varus torque, arm speed, and velocity with and without the dynamic arm stabilizer. Significance was set at an alpha level of $p < 0.05$ to remain consistent with previous studies conducted on elbow stresses in baseball pitchers.[10,13]

RESULTS

Varus Torque, Arm Speed, and Velocity

When assessing relationships between varus torque, arm speed, and velocity, several correlations were statistically significant. Significant correlations when wearing the dynamic arm stabilizer are included in Table 1. Significant correlations when not wearing the dynamic arm stabilizer are included in Table 2.

Table 1. Significant correlations when wearing the dynamic arm stabilizer.

Factors	Correlation	Effect Size	Strength
Varus Torque and Arm Speed	$r(198) = .306, p < .001$	0.09	Negligible Positive
Varus Torque and Velocity	$r(198) = .528, p < .001$	0.28	Small Positive
Arm Speed and Velocity	$r(198) = .640, p < .001$	0.41	Moderate Positive

Table 2. Significant correlations when not wearing the dynamic arm stabilizer.

Factors	Correlation	Effect Size	Strength
Varus Torque and Velocity	$r(198) = .562, p < .001$	0.32	Moderate Positive
Arm Speed and Velocity	$r(198) = .412, p < .001$	0.17	Small Positive

Differences Between Wearing and not Wearing Dynamic Arm Stabilizer

Throwing with the dynamic arm stabilizer resulted in significant decreases in varus elbow torque when compared to throwing without the dynamic arm stabilizer (stabilizer = 45.80 ± 8.12 Nm, no stabilizer = 51.85 ± 8.87 Nm, $p < .001$). Throwing with the dynamic arm stabilizer also resulted in significant decreases in arm speed compared to throwing without the dynamic arm stabilizer (stabilizer = 857.39 ± 59.64 degrees per second, no stabilizer = 876.58 ± 82.74 degrees per second, $p < .001$). A significant difference in velocity of 0.82 miles per hour was found when wearing the dynamic arm stabilizer compared to not wearing the dynamic arm stabilizer (stabilizer = 70.95 ± 5.21 mph, no stabilizer = 71.77 ± 5.68 mph, $p < .001$).

DISCUSSION

The purpose of this study was to determine if a dynamic arm stabilizer would influence varus elbow torque, arm speed, and throwing velocity in collegiate baseball players. Given the increasing prevalence of shoulder and elbow injuries in baseball players, a means of mitigating torque on the elbow and shoulder during throwing warrant further investigation.[13-15] Results from the current study indicate at a dynamic arm stabilizer decreases varus elbow torque, arm speed, and throwing velocity when throwing on flat ground at 90 feet. These decreases may have varying levels of clinical meaningfulness.

Previous studies have shown that 34-35 Nm of external valgus force is necessary to rupture the ulnar collateral ligament in in-vitro settings.[9,18,19] This seems to contrast the fact that ulnar collateral ligament regularly undergoes between 45 and 120 Nm of valgus force.[10,11,19] This is likely because these previous studies do not account for the force dissipated to the surrounding musculature.[20] This data leaves room for debate regarding how much torque would need to decrease at the elbow in order to be clinically meaningful. Nevertheless, it is apparent that dynamic stabilization has a protective effect on the ulnar collateral ligament when valgus force is introduced. A decrease of over 6 Nm of force provided by an external dynamic stabilizer would appear to be a large enough difference to potentially keep an individual from exceeding the tensile threshold during a throw that may otherwise lead to disruption of the ligament's integrity.

Arm speed was also found to have a significant correlation with throw velocity with and without the dynamic arm stabilizer. From an application standpoint, this would suggest that significant decreases in arm speed could have an impact on velocity. The decrease in mean arm speed when wearing the dynamic arm stabilizer in this study was 19.19 degrees per second. Interestingly, arm speeds measured in youth, collegiate, and professional pitchers did not reveal much variability.[21] This implies that there are other variables besides arm speed that impact the resultant velocity of a throw. As such, it is difficult to infer the clinical meaningfulness of a 19.19 degree per second decrease in velocity.

Among coaches, players, and reporters, a pitcher's velocity is often associated with success.[22,23] The rationale is that a higher pitch velocity will give hitters less time to react. On average, a hitter has 0.40 seconds to determine the type of pitch that was thrown, the location the ball will cross home plate, the velocity of the pitch, finish their swinging motion, and get the bat to the ball.[24] In this study, throwing wearing a dynamic arm stabilizer resulted in a 0.82 mile per hour decrease in throwing velocity at 90 feet. It is difficult to equate throwing from 90 feet on flat ground to throwing from 60.5 feet off a regulation pitching mound. However, a decrease in throwing velocity is likely to discourage pitchers from using an intervention. It is important to note that a 0.82 mile per hour decrease in throwing velocity would result in a hitter having an additional 0.01 seconds to react to, and hit, a pitch. Additionally, pitchers would likely not be wearing a dynamic arm stabilizer when pitching competitively. This means the decrease in velocity during throwing would likely not carry over to pitching.

Limitations
One limitation of this study was the sample size selected. Since the sampling was a convenience sampling based on availability, the sample size may not have been large enough to completely answer the research question. Another limitation was that data was collected when throwing on flat ground at 90 feet. There may be some difference in measurement taken with pitchers throwing from a regulation mound at 60.5 feet.

Recommendation for Future Research
There is a need for future research to determine the effect of a dynamic arm stabilizer on pitching from a regulation mound at 60.5 feet. Further research should also be conducted to determine the average threshold in varus torque needed to rupture the ulnar collateral ligament when pitching. Such research should also incorporate a larger sample size to allow for more generalizable results.

CONCLUSIONS
In conclusion, use of a dynamic arm stabilizer results in a decrease in varus elbow torque when throwing on flat ground at 90 feet. The dynamic arm stabilizer also resulted in a decrease in arm speed and throwing velocity when compared to throwing without a dynamic arm stabilizer. Further research is needed to determine the clinical meaningfulness of these findings in order to determine the best application for a dynamic arm stabilizer in baseball players.

REFERENCES:

1. Camp CL, Zajac JM, Pearson DB, et al. Decreased shoulder external rotation and flexion are greater predictors of injury than internal rotation deficits: Analysis of 132 pitcher-seasons in professional baseball. *Arthroscopy.* 2017;33(9):1629-1636.
2. Erickson BJ, Harris JD, Fillingham YA, et al. Surgical treatment of ulnar collateral ligament and superior labral tears by Major League Baseball team physicians. *Arthroscopy.* 2016;32(7):1271-1276.
3. Erickson BJ, Jain A, Abrams GD, et al. SLAP lesions: Trends in treatment. *Arthroscopy.* 2016;32(6):976-981.
4. Lyman S, Fleisig GS, Andrews JR, et al. Effect of pitch type, pitch count, and pitching mechanics on the risk of elbow and shoulder pain in youth baseball pitchers. *Am J Sports Med.* 2002;30(4):463-468.
5. Lyman S, Fleisig GS, Waterbor JW, et al. Longitudinal study of elbow and shoulder pain in youth baseball pitchers. *Med Sci Sports Exerc.* 2001;33(11):1803-1810.
6. Tullos HS, King JW. Throwing mechanism in sports. *Orthop Clin North Am.* 1973;4(3):709-720.
7. Ievleva L, Orlick T. Mental links to enhance healing: An exploratory study. *Sport Psychology.* 1991;5:25-40.
8. Trigt BV, Vliegen LW, Leenen TA, Veeger DH. The ulnar collateral ligament loading paradox between in-vitro and in-vivo studies on baseball pitching (narrative review). *International Biomechanics.* 2021;8(1):19-29.
9. McGraw MA, Kremchek TE, Hooks TR, Papangelou C. Biomechanical evaluation of the docking plus ulnar collateral ligament reconstruction technique compared with the docking technique. *Am J Sports Med.* 2013;41(2):313-320.
10. Aguinaldo AL, Chambers H. Correlation of throwing mechanics with elbow valgus load in adult baseball pitchers. *Am J Sports Med.* 2009;37(10):2043-2048.
11. Gasparutto X, Va Der Graaff E, Van Der Helm FCT, Veeger HEJ. Elite athlete motor and loading actions on the upper limb in baseball pitching. *Procedia Eng.* 2016;147:181-185.
12. Bonza JE, Fields SK, Yad EE, Comstock RD. Shoulder injuries among high school athletes during the 2005-2006 and 2006-2007 school years. *Journal of Athletic Training.* 2009;44:76-38.
13. Cage SA, Dong XN, Warner BJ, Gallegos DM. Comparison of pitching from flat ground vs. 10-inch mound regarding elbow varus torque and arm speed. *Journal of Sports Medicine and Allied Health Sciences.* 2019;5(2).

14. Ling D, Camp CL, Dowling B, Mcelheny K, Dines JS. Flat ground throwing results in decreased velocity and increased elbow torque during mound throwing. *The Orthopaedic Journal of Sports Medicine.* 2019;7(7).
15. Boddy KJ, Marsh JA, Caravan A, Lindley KE, Scheffey JO, O'Connell ME. Exploring wearable sensors as an alternative to marker-based motion capture in the pitching delivery. *PeerJ.* 2019;7:e6365.
16. The Perfect Arm, LLC. How it works. Available online: https://thekineticarm.com/pages/how-it-works (Accessed on August 3, 2022).
17. Burger E, Aguinaldo A. Validation of a wearable sensor in the estimation of elbow varus torque during baseball pitching. *Medicine and Science in Sports and Exercise.* 2020;52(7S):259.
18. Trigt BV, Vliegen LW, Leenen TA, Veeger DH. The ulnar collateral ligament loading paradox between in-vitro and in-vivo studies on baseball pitching (narrative review). *International Biomechanics.* 2021;8(1):19-29. Doi: 10.1080.23335432.2021.1916405
19. Smith MV, Bernholt DL. Ulnar collateral ligament injury in the elbow: Current trends for treatment. *Annals of Joint.* 2020;5. Doi: 10.21037/aoj.2020.01.02
20. Udall JH, Fitpatrick MJ, McGarry MH, et al. Effects of flexor-pronator muscle loading on valgus stability of the elbow with an intact, stretched, and resected medial ulnar collateral ligament. *J Shoulder Elbow Surg.* 2009;18:773-778. Doi: 10.1016/j.jse.2009.03.008
21. Fleisig GS, Barrentine SW, Zheng N, Escamilla RF, Andrews JR. Kinematic and kinetic comparison of baseball itching among various levels of development. *Journal of Biomechanics.* 1999;32(12):1371-1375. Doi: 10.1016/s0021-9290(99)00127-x
22. Dorosh K, Prusaczyk J, Stokesbury S. The relative importance of velocity. August 30, 2016. Available online: https://tht.fangraphs.com/the-relative-importance-of-velocity/ (Accessed on August 4, 2022)
23. Marcano C. The real influence of velocity. June 11, 2021. Available online: https://www.pitcherlist.com/the-real-influence-of-velocity/#:~:text=For%20a%20pitcher%2C%20like%20Canning,the%20possibility%20of%20a%20breakout. (Accessed on August 4, 2022)
24. Reaction time (in seconds) for baseball pitches by speed and distance. August, 14, 2008. Available online: https://www.efastball.com/baseball/pitching/grips/reaction-time-for-baseball-hitters/#:~:text=Hitters%20have%20roughly%200.40%20seconds,speed%20of%20the%20pitched%20ball (Accessed on August 4, 2022)