Journal of Sports Medicine and Allied Health Sciences: Official Journal of the Ohio Athletic Trainers Association

Volume 5
Issue 2 *JSMAHS Fall Issue 2019*

Article 5

July 2019

Comparison of Pitching from Flat Ground vs. 10-Inch Mound Regarding Elbow Varus Torque and Arm Speed

Stephen A. Cage
The University of Texas at Tyler; The University of North Carolina, Greensboro, sacage@uncg.edu

X. Neil Dong
The University of Texas at Tyler

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

Diana M. Gallegos
University of Texas at Tyler, dgallegos@atsu.edu

Recommended Citation

Cage, Stephen A.; Dong, X. Neil; Warner, Brandon J.; and Gallegos, Diana M. (2019) "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: Official Journal of the Ohio Athletic Trainers Association*: Vol. 5 : Iss. 2 , Article 5.
DOI: https://doi.org/10.25035/jsmahs.05.02.05
Available at: https://scholarworks.bgsu.edu/jsmahs/vol5/iss2/5

Comparison of Pitching from Flat Ground vs. 10-Inch Mound Regarding Elbow Varus Torque and Arm Speed

Stephen A. Cage, M.Ed, LAT, ATC[*]; X. Neil Dong, PhD[*]; Brandon J. Warner, M.Ed, LAT, ATC[€]; Diana M. Gallegos, MS, LAT, ATC[*]

[*]The University of Texas at Tyler; [€]Grand Canyon University

Purpose: The purpose of this study was to examine the effect of throwing surface and distance on varus elbow torque and arm speed. **Methods:** 11 male collegiate baseball pitchers (age = 20.73 ± 1.56 years, height = 175.26 ± 9.03 cm, mass = 70.31 ± 9.03 kg) participated in this study. Varus elbow torque and distance were measured using a 3D motion sensor housed in a spandex sleeve at the medial joint line of the elbow. Subjects were instructed to complete their normal warmup routine as if they were about to pitch in a bullpen session or a game. Subjects were then fitted with the sleeve and 3D motion sensor and then instructed to throw 5 maximum effort fastballs at both 60 feet 6 inches and 50 feet 6 inches from a 10-inch mound and 5 maximum effort fastballs at both 60 feet 6 inches and 50 feet 6 inches from flat ground. A two-way analysis of variance with repeated measures was used to analyze the differences in elbow varus torque and arm speed when pitching from 60 feet 6 inches and 50 feet 6 inches from a 10-inch mound and from flat ground. Tests of significance were carried out at an alpha level $p < 0.05$. **Results:** Significant differences in elbow varus torque were found when throwing from a 10-inch mound compared to flat ground (10-inch mound = 46.99 ± 2.36, Flat ground = 42.67 ± 3.14). No significant differences in elbow varus torque were found when throwing from 60 feet 6 inches compared to 50 feet 6 inches regardless of surface (60 feet 6 inches = 45.38 ± 2.96, 50 feet 6 inches = 44.28 ± 2.59). No significant differences in arm speed were found regardless of surface or distance. **Conclusions:** Throwing from a 10-inch mound appears to place more torque on the elbow than throwing from flat ground. Clinicians should be mindful of this fact when progressing patients through throwing programs. **Key Words:** *baseball, UCL, pitcher, motus, valgus stress*

INTRODUCTION

Over the past 15 years the incidence of shoulder and elbow injuries in adolescent baseball pitchers has increased.[1,2] Across all sports involving overhead activity, baseball pitchers are at the highest risk of acute and chronic upper extremity pathology. Ulnar collateral ligament (UCL) are the most common .[3] These injuries are believed to occur as a result of structural failure following elevation of tension with a varus moment at the medial elbow.[4] In patients suffering from UCL injuries, the most common method of treatment is ligament reconstruction.[5] Following reconstruction, patients miss an average of 10 months of participation in their chosen physical activity.[6] To reduce the prevalence of these injuries youth baseball organizations have implemented pitch counts, mandatory rest days, and age limits on pitches such as curveballs.[7] However, the current literature reveals that upper extremity injury prevalence is still increasing among baseball pitchers.[1]

Following conservative or surgical treatment of upper extremity pathology, traditional injury management has called for a throwing program to progress pitchers toward returning to full activity.[3] These throwing programs often recommend that pitchers are able to throw at distances further than they would be pitching (120-180 feet) for prolonged periods of time prior to beginning to throw from a mound. In spite of this traditional method, there has been research that has shown throwing from flat ground surfaces of 120-180 feet places more torque on the elbow and shoulder than pitching from a mound at 60.5 feet.[8] This information has

been available in the current literature for some time, but may not be being fully utilized when throwing programs are being administered. Namely, coaches may not be considering the best available research regarding forces placed on the elbow and shoulder when determining distance, volume, and frequency in throwing programs for pitchers. To date, available studies do not appear to have been conducted using 3D motion analysis to compare elbow varus torque when throwing from a 10-inch mound at 60 feet 6 inches, throwing from a 10-inch mound at 50 feet 6 inches, and throwing from flat ground at the same distances. Thus the aim of this study was to use the 3D motion sensor sleeve developed by Motus Global to assess elbow varus torque and arm speed from a 10-inch mound at 60 feet 6 inches, a 10-inch mound at 60 feet 6 inches, and from flat ground at the same distances. The authors hypothesized that throwing from a 10-inch mound and from 60 feet 6 inches would result in greater varus elbow torque compared to throwing from flat ground and from 50 feet 6 inches. A secondary hypothesis was that throwing in all conditions would not result in a change in arm speed, as all subjects would be instructed to throw with maximum effort in all conditions.

METHODS

Subjects

The investigators recruited 11 male collegiate baseball pitchers (age = 20.73 ± 1.56 years, height = 175.26 ± 9.03 cm, mass = 70.31 ± 9.03 kg) participated in this study. Subjects did not have a history of severe injury that warranted surgery to the dominant upper extremity as reported by the subject and had no history of dominant upper extremity injury over the previous 6 months. Subjects for this test were otherwise apparently healthy. All subjects signed an informed consent document approved by the university's institutional review board.

Warmup and Pitching Procedures

All subjects were reported to behave and conduct themselves as if they were preparing for a normal bullpen session during which they would practice pitching. Each subject was given as long as they needed to warm up to pitch. Warm ups generally consisted of elastic tubing exercises, hip mobility exercises, and throwing at gradually increasing distance and intensity. Subjects were then fitted with a spandex sleeve that housed a 3D motion sensor (Motus Sleeve, Motus Global, Rockville Centre, NY) at the medial joint line of the elbow. Subjects were then instructed to make sure the sensor remained on their medial joint line and told to inform the investigator if they felt the sensor had moved after a pitch. Subjects were randomly assigned via drawing to begin pitching either from a 10-inch mound at 60 feet 6 inches or from flat ground at 60 feet 6 inches (Figure 1). This randomization was done in an attempt to minimize the effects of fatigue the investigators felt may result from the testing procedures if throwing from a mound did result in increased torque or arm speed. The subjects would then throw 5 maximum effort fastballs followed by another 5 maximum effort fastballs from 50 feet 6 inches. After completion of these pitches, the subject would then move to the surface they had not started on and throw another 5 maximum effort fast balls from 60 feet 6 inches and another 5 from 50 feet 6 inches.

Figure 1. Subject throwing from 10-inch mound with 3D motion sensor sleeve on his throwing arm.

3D Motion Sensor Testing Procedures

Subjects were fitted with a sleeve housing a 3D motion sensor at the medial joint line of the elbow using the medial humeral epicondyle as a land mark and instructed as to where the sensor should rest before and after each pitch. During each pitch, the motion sensor would capture the amount of force being placed on the medial elbow in Newton meters (Nm), as well as the arm speed in revolutions per minute (RPM). Time between pitches was limited to a maximum of 15 seconds in an attempt to simulate a normal bullpen session for the subjects. The data captured would then be send to a smartphone application created by the company that created the sensor (Motus Throw, Motus Global, Rockville Centre, NY).

Statistical Analysis

A two-way, 2 (surface) x 2 (distance) repeated measures analysis of variance (ANOVA) was used to analyze the difference between pitching from a 10-inch mound at distances of 60 feet 6 inches and 50 feet 6 inches and pitching from flat ground at distances of 60 feet 6 inches and 50 feet 6 inches on elbow varus torque and arm speed. Significance was set at an alpha level of $p < 0.05$. Statistical procedures were performed using the IBM SPSS Software (IBM, Armony, NY).

RESULTS

Elbow Varus Torque

Means and standard deviations/errors for elbow varus torque by condition (10-inch mound from 60 feet 6 inches, 10-inch mound from 50 feet 6 inches, flat ground from 60 feet 6 inches, flat ground 50 feet 6 inches) are presented in Table 1. A statistically significant difference was found between throwing from a 10-inch mound compared to throwing from flat ground (p=0.021). A statistically significant interaction was not found between throwing from 60 feet 6 inches and 50 feet 6 inches regardless of surface (p = 0.515). Comparison of elbow varus torque measures indicate that throwing from a mound significantly increases the torque being placed on the medial elbow. However, a 10-foot difference did not significantly impact the amount of torque being placed on the medial elbow.

	10-Inch Mound	**Flat Ground**	**Total**
60 feet 6 inches	47.18 ± 10.33	43.58 ± 10.47	45.38 ± 2.96
50 feet 6 inches	46.80 ± 8.19	41.76 ± 11.30	44.28 ± 2.59
Total	46.99 ± 2.36*	42.67 ± 3.14	

Table 1. Mean ± SD scores for elbow varus torque in Nm. Totals are represented with Mean ± SE scores.
** = Significant*

Arm Speed

Means and standard deviations/errors for arm speed by condition (10-inch mound from 60 feet 6 inches, 10-inch mound from 50 feet 6 inches, flat ground from 60 feet 6 inches, flat ground 50 feet 6 inches) are presented in Table 2. No statistically significant interactions were observed between any conditions (p=0.538). Comparison of arm speed measures indicate that subjects pitched with the same arm speed regardless of condition.

	10-Inch Mound	**Flat Ground**	**Total**
60 feet 6 inches	991.96 ± 94.00	980.40 ± 94.54	982.68 ± 26.22
50 feet 6 inches	973.40 ± 89.70	985.93 ± 92.91	983.16 ± 27.19
Total	986.18 ± 27.76	979.66 ± 26.04	

Table 2. Mean ± SD scores for arm speed in RPM. Totals are represented with Mean ± SE scores.

DISCUSSION

The purpose of this study was to determine if pitching from a 10-inch mound affected elbow varus torque and arm speed when compared to pitching from flat ground. Results from the current study indicate that regardless of condition, individuals pitch with the same arm speed when instructed to use maximum effort. Results also indicate that pitching from a 10-inch mound increases the amount of varus torque placed on the medial elbow during pitching.

While there are steps being taken in an attempt to decrease the prevalence of these injuries including pitch volume and type restrictions, they do not appear to be significantly decreasing the number of injuries occurring.[1,2,7] Earlier studies have attempted to evaluate the forces being placed on the elbow, but have primarily utilized 3D cameras and motion analysis to do so.[8] Use of wearable technology such as a 3D motion sensor sleeve may allow for more data to be collected in the field. This form of data collection may allow athletic trainers and coaches to monitor pitchers throughout the season to assess the torque being placed on the elbow over a longer period of time. The current study supplements the findings of earlier work by showing that when compared at the same distance, throwing from a 10-inch mound places more torque on the elbow than throwing from flat ground.

While previous literature suggests that throwing from 120-180 feet places more torque on the elbow and shoulder when compared to pitching from a 10-inch mound at 60 feet 6 inches, the authors were unable to find studies examining torque on the elbow or shoulder at shorter distances.[8] When pitchers begin throwing following a significant injury to the upper extremity, they must complete a throwing program to regain velocity and endurance prior to returning to pitching.[3] Knowledge about the amount of torque placed on the elbow at shorter distances when performing pitching mechanics may help inform athletic trainers and other allied healthcare professionals about how best to progress patients through their throwing program.

The findings of the current study indicated that there is a significant effect on varus elbow torque caused by pitching from a 10-inch mound. 3D motion sensor results suggest that subjects' elbows were subjected to more torque when throwing from a 10-inch mound (46.99 ± 2.36) compared to flat ground (42.67 ± 3.14). The findings of the current study provide further information to supplement previous findings that suggest that throwing from 120-180 feet places more torque on the elbow than pitching from 60 feet 6 inches.[8]

LIMITATIONS

The current study only assessed subjects in a practice setting. It is possible that pitching in a game would affect the amount of torque being placed on the elbow and arm speed. Additionally, subjects only threw fast balls when data was being collected. The throwing mechanics of other pitches may have an effect on both torque and arm speed.[1] Lastly, given that individuals only threw five pitches in each condition, it is possible that fatigue would have affected the amount of torque being placed on the elbow and arm speed.

FUTURE RESEARCH

There is a need for additional research on the effects of throwing different pitches on the amount of torque being placed on the elbow and arm speed. There is also a need for research on the effects of fatigue following throwing multiple pitches on the amount of torque being placed on the elbow and arm speed. Future research should be directed toward assessing these two factors and their affects on the amount of torque being placed on the elbow and arm speed.

CONCLUSIONS

In conclusion, pitching from a 10-inch mound appears to place more varus torque on the elbow when compared to pitching from flat ground. Pitching from 60 feet 6 inches, however, did not place more varus torque on the elbow when compared to pitching from 50 feet 6 inches. These findings suggest that pitching from flat ground places less torque on the elbow and therefore may result in a lower risk of elbow injury. The results from this study may assist athletic trainers and other allied healthcare professionals as they design throwing programs for individuals returning to participation. Given that pitching from a 10-inch mound increased varus torque being placed on the elbow, a clinician must ensure that their patient is physical capable of pitching from a mound in terms of tissue

healing, strength, and range of motion prior to being allowed to do so.

REFERENCES

1. Dun S, Loftice J, Fleisig GS, Kingsley D, Andrews JR. A biomechanical comparison of youth baseball pitches: Is the curveball potentially harmful? *Am J Sports Med.* 2008;36:686-692. DOI: 10.1177/0363546507308938
2. Nissen C, Westwell M, Ounpuu S, et al. Adolescent baseball pitching technique: a detailed three-dimensional biomechanical analysis. *Med Sci Sports Exerc.*2007;39:1347-1357. DOI: 10.1249/mss.0b013e318064c88e
3. Dines J, Altchek D. *Elbow Ulnar Collateral Ligament Injury: A Guide to Diagnosis and Treatment.* New York, NY: Springer Science; 2015.
4. McGraw MA, Kremchek TE, Hooks TR, Papangelou C. Biomechanical evaluation of the docking plus ulnar collateral ligament reconstruction technique. *Am J Sports Med.* 2013;41:313-320.
5. Anz AW, Bushnell BD, Griffin LP, Noonan TJ, Torry MR, Hawkins RJ. Correlation of torque and elbow injury in professional baseball pitchers. *Am J Sports Med.* 2010;38:1368-1374. DOI: 10.1177/0363546510363402
6. Hariri S, Safran MR. Ulnar collateral ligament injury in the overhead athlete. *Clin Sports Med.* 2010;29:619-644. DOI: 10.1016/j.csm.2010.06.007
7. Axe M. Recommendations for protecting youth baseball pitchers. *Sports Med Arthrosc Rev.* 2001;9:147-153.
8. Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF. Kinetics of baseball pitching with implications about injury mechanisms. *Am J Sports Med.* 1995;23:233-39.