

Assessing UCL Width During Valgus Load In College Baseball Pitchers Using Ultrasound Imaging

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Abstract

Injuries to the Ulnar Collateral Ligament (UCL) of the elbow are common in overhead throwing athletes. A repetitive valgus force during the throwing motion places significant stress on the UCL. More research needs to be conducted investigating new methods to assess potential thickening of the anterior bundle of the UCL in order to understand ligament changes that may occur throughout the season. **PURPOSE:** To examine the reliability of ultrasound imaging measurements of UCL width at 2 different anatomical locations using 5 Nm valgus stress; and to determine if a difference in ligament width exists between the two measurements 4 weeks apart within the same season. **METHODS:** Thirteen Division I college men's baseball pitchers participated with a mean age of 20.4±1.45 SD and body mass index of 24.56±1.78 SD). Ultrasound images were obtained of the anterior band of the UCL on the participant's throwing arm using a GE LOGIQ E ultrasound unit with a linear probe at 12 MHz. Participants were placed in a supine position with a wedge placed underneath their forearm to maintain their elbow position at a 30 deg. flexion angle. A 5 Nm valgus stress was applied 20 centimeters distal to the medial epicondyle. Measurements at the mid substance and the apex of the trochlea were taken at the beginning of the baseball season and then again 4 weeks later by two different raters. Three images were measured during each session. **RESULTS:** Intra-rater reliability as expressed by ICC (3,3) was .929 (SEM= 0.18 mm) for the pretest measurement and .935 (SEM= 0.20 mm) for the posttest measurement for the apex of trochlea measurement site. For the mid-substance measurement site, reliability estimates of .861 (SEM= 0.22 mm) was found for the pretest measurement and .920 (SEM=0.16 mm) for the posttest measurement, indicating excellent intra-rater reliability. There was no significant difference between the measurements obtained on the two testing dates (Apex of trochlea mean width 2.90 mm & 2.92 mm; $t = -.155$; $P \geq 0.05$) and (Mid-substance mean width 4.49 mm & 4.44 mm; $t = .571$; $P \geq 0.05$). **CONCLUSIONS:** Excellent intra-rater reliability was found at all four measurement sites. There was no significant difference in UCL width from the beginning of the season and one-month into the season. Further research is recommended to perform multiple imaging sessions throughout the year to determine the long term physiological effects of overhead throwing on the anterior band of the UCL as well as to better understand the relationship between UCL width changes, tissue quality, and injury risk.

Introduction

Injuries to the Ulnar Collateral Ligament (UCL) of the elbow are common in overhead throwing athletes. Injuries to the elbow accounted for 9.3% of game injuries and 10.8% of practice injuries¹, and injuries to the Ulnar Collateral Ligament (UCL) of the elbow have become increasingly common in overhead throwing athletes. Most UCL injuries occur early in the season.² A repetitive valgus force during the throwing motion places significant stress on the UCL.³ Currently, athletes who suffer a tear of the UCL undergo a surgical repair to reconstruct the UCL, known as Tommy John surgery. This procedure is highly successful, however, is costly and has a very extensive and long rehabilitation program that places quite a burden on the athletes themselves and the team.⁴ More research needs to be conducted to investigate new methods to assess potential thickening of the anterior bundle of the UCL, in order to understand physiologic changes in the ligament throughout the season.^{5,6} The purpose of this study was to examine the reliability of UCL width measurements by means of ultrasound imaging, and to determine the presence of any differences in ligament width between pretest and posttest measurements.

Methods

Subjects: Thirteen Division I college men's baseball pitchers participated with a mean age of 20.4±1.45 SD and body mass index of 24.56±1.78 SD. Subjects gave written informed consent before participating, and the protocol was approved by Florida Gulf Coast University's Institutional Review Board.

Design: A repeated measures, non-randomized experimental design was used to study the intra-rater reliability of UCL width measurements on two different measurement dates four weeks apart (pretest and posttest). Three measurements of the UCL were taken at both measurement dates, at two locations: at the ligament mid-substance and the apex of the trochlea. In addition, changes in ligament width between measurement dates were evaluated at both locations.

Methods Cont.

Procedure: Ultrasound images were obtained of the anterior band of the UCL on the participant's throwing arm using a GE LOGIQ E ultrasound unit (GE Healthcare, Chicago, IL) with a linear probe at 12 MHz. Participants were placed in a supine position with a wedge placed underneath their forearm to maintain their elbow position at a 30 degree flexion angle. A 5 Nm valgus stress was applied 20 centimeters distal to the medial epicondyle (see Fig. 1) Measurements at the mid substance and the apex of the trochlea were taken (see Fig. 2) at the beginning of the baseball season (pretest) and then again 4 weeks later (posttest). Three images were measured during each session.



Figure 1. Sonographic evaluation with valgus load measurement



Figure 2. UCL with thickness measurements during valgus load

Statistical Analysis

Intra-rater reliability analysis was performed by calculating Intraclass Correlation Coefficients (ICC), Model (3,3). An ICC is a measure of reliability among variables within groups. In this study, we calculated the ICC, Model (3,3) in order to determine the intra-rater repeated measure reliability when measuring the anterior UCL at the mid-substance point and the apex of the trochlea for each data collection session.

Paired Sample t-tests were conducted comparing the mean thickness of the UCL measures obtained from the pretest and posttest session at each anatomical location. The level of significance was accepted at an alpha level of $P < 0.05$.

Results

The intra-rater reliability as expressed by ICC (3,3) for the apex of trochlea measurement site was 0.929 (SEM: 0.18 mm) for the first measurement date and .935 (SEM: 0.20 mm) for the second measurement date. The intra-rater reliability as expressed by ICC (3,3) for the mid-substance measurement site was 0.861 (SEM: 0.22 mm) for the first measurement date, and 0.920 (SEM=0.16 mm) for the second measurement date, indicating excellent intra-rater reliability (see Table 1).

Table 1: Intra-rater reliability

	ICC (3,3)	95% Confidence Interval	F test	Df	Sig
Apex of Trochlea Measurement 1	.929	.817-.978	40.01	12	0.000
Apex of Trochlea Measurement 2	.935	.846-.978	44.26	12	0.000
Mid substance Measurement 1	.861	.670-.957	19.65	12	0.000
Mid substance Measurement 2	.920	.811-.972	35.34	12	0.000

There was no significant difference between the pretest and posttest measurements (see Table 2) at both anatomical locations obtained on the two testing dates.

(Apex of trochlea mean width 2.90 mm & 2.92 mm; $t = -.155$; $P \geq 0.05$)
(Mid-substance mean width 4.49 mm & 4.44 mm; $t = .571$; $P \geq 0.05$)
(see Table 3).

Table 2: UCL Width At Both Locations (mean, SD, and SE)

	Mean Width	SD	SE
Apex of Trochlea Pretest	2.909	.816	.226
Apex of Trochlea Posttest	2.920	.780	.216
Mid substance Pretest	4.491	.639	.177
Mid substance Posttest	4.447	.564	.153

Table 3: Paired Samples t-test

	Mean Difference	t value	df	Sig. (2-tailed)
Pair 1: Apex of trochlea Pretest to Posttest	-.0115	-.155	12	.880
Pair 2: Mid substance Pretest to Posttest	.0439	.571	12	.578

Discussion

The results from this study demonstrated excellent intra-rater reliability for measurement of the width of the UCL at both locations and both sessions. This is the first study identified that has analyzed the intra-rater reliability of measurement of the the width of the anterior bundle of the UCL. This is important because clinicians can now reliably use ultrasound imaging within the clinical setting to measure and monitor changes in the anterior band of the UCL throughout the season. In the past decade, there has been an increase in awareness placed on UCL injuries baseball players. Therefore, an imaging modality that can reliably detect physiologic changes to the anterior band of the UCL could be beneficial to early detection of potential injuries and identification of potential injury risk.

This study did not find differences in ligament thickness between the two measurement dates that were four weeks apart. The mean thickness found at the UCL mid substance was slightly below the values found by Nazarian et al.⁵, however our study was performed with college baseball pitchers rather than the professional pitchers of that study. This difference in thickness between these two populations is consistent with the finding of Ciccotti et al.⁷ that the thickness of the anterior band of the UCL increases with the number of years paying baseball.

Limitations of this study include the sample size of our study, the limited number of measurements, the limited amount of time between the measurements, and the lack of control for the number of pitches thrown.

Conclusions

Further research is recommended to perform multiple imaging sessions throughout the year to determine the long term physiological effects of overhead throwing on the anterior band of the UCL and to study the connection between UCL width changes, tissue quality, and injury risk.

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