

Ultrasound Imaging to Evaluate Acute Adaptations of the Medial Elbow Joint Complex in College Baseball Pitchers

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Abstract

Context: Musculoskeletal ultrasound imaging (MSKUI) has become an increasing studied assessment tool in orthopedic sports medicine. Several studies have investigated ulnar collateral ligament (UCL) integrity and morphology in the throwing arm of baseball players with MSKUI. Research data has indicated that UCL thickening and medial joint space (MJS) widening occurs in athletes during sustained competition. **Objective:** To examine acute UCL thickness and MJS adaptations in the throwing arm of Division I collegiate baseball pitchers with MSKUI following one in-game performance. **Design:** Non-experimental descriptive quantitative repeated measures study. **Participants:** Ten NCAA Division I collegiate baseball pitchers (mean age 20.4 ± 1.4 yrs) with no history of significant upper extremity injuries participated. **Methods:** Musculoskeletal ultrasound images were obtained with a GE LOGIQ e ultrasound unit before and immediately after (< 15 minutes) pitching performance during each subject's first game of the season. A 3 kg valgus force was applied with a handheld dynamometer (Hoggan Scientific microFET 2) 20 cm distal to the medial epicondyle of the throwing arm during imaging. Post-imaging ligament thickness measurements were performed at the mid-substance of UCL and at the apex of the trochlea. Moreover, post-imaging measurements were performed from the apex of the trochlea to the apex of the ulna to evaluate MJS. Changes to UCL thickness (mid-substance and apex of the trochlea) and MJS were analyzed using paired samples t-tests. **Results:** There was no significant difference in mid-substance UCL thickness width before (5.72 ± 0.7mm) and after performance (5.70 ± 0.7mm; t (9) = .36, p = .73). With respect to apex of trochlea UCL width, no significant differences were found before (2.67 ± 0.7mm) and after (2.61 ± 0.6mm; t (9) = 1.30, p = .23) performance. When assessing MJS, a significant change of -4% was observed before (6.30 ± 1.5mm) and after (6.60 ± 1.5mm; p = .005). Controlling for the pitch count [F (1,9) = .17, p = .69] and innings pitched [F (1,9) = .06, p = .81] did not affect the change in MJS. **Conclusions:** A significant MJS widening did occur after one pitching outing at the start of the season; whereas, no changes were observed in UCL thickness measured at two different locations. Further research is needed to understand the etiology of increased medial elbow joint widening in pitchers at the start of the collegiate baseball season.

Introduction

Musculoskeletal ultrasound imaging (MSKUI) has the ability to dynamically monitor musculoskeletal structures, offers a degree of extra visibility over magnetic resonance imaging (MRI), is more cost efficient, and is free of radiation.^{1,2} MSKUI is becoming a growing topic in the literature regarding the imaging of musculoskeletal injuries. Several studies have investigated the composition and integrity of the ulnar collateral ligament (UCL) with imaging.^{3,4,5,6} Some research suggests that UCL thickness and MJS width increases in professional baseball players through sustained competition and experience.^{5,6} What these changes mean in relation to injury has yet to be determined in the research literature, but there are no studies that explore acute changes in following performance. Such research may highlight the time frame and work load required to induce structural adaptations in baseball players. The purpose of this study is to explore acute UCL thickness, and medial joint space (MJS) width adaptations in the throwing arm of collegiate pitchers.

Methods

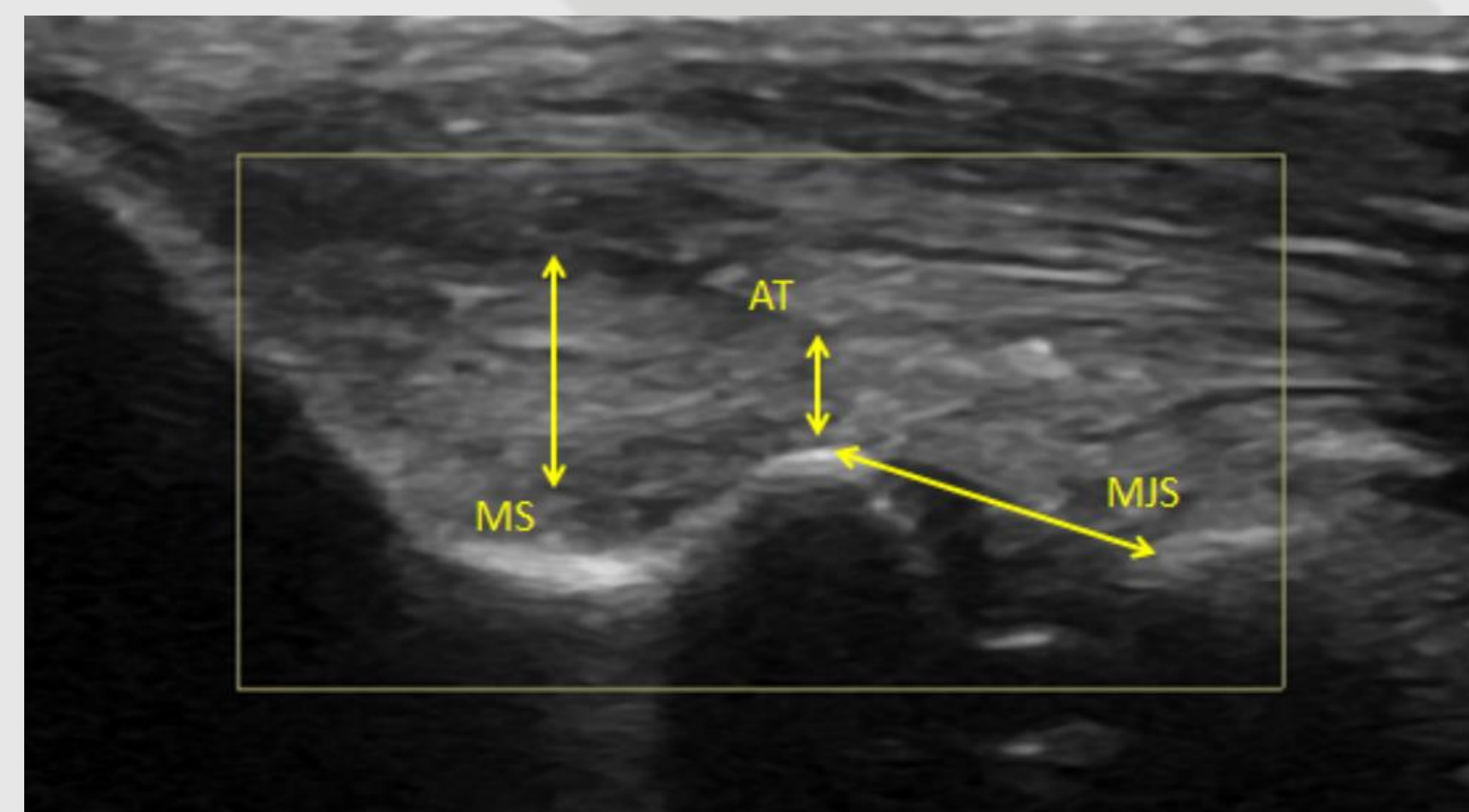
Subjects: All participants were recruited from an NCAA Division I collegiate baseball team. The inclusion criterion was all pitchers that were to compete in their first game of the season during the first home series. The sample in this study included 10 participants. The only exclusion criteria was any athlete that had prior history UCL reconstruction in their throwing arms. The ten pitchers included were comprised of three freshmen, four juniors, two seniors and one red-shirted junior. Eight were right-handed pitchers and two were left handed pitchers. Other demographic data of the participants included a mean age of 20.4 ± 1.4 SD years (range, 18 to 23), mean height of 73.5 ± 1.3 SD inches (range, 72 to 76), mean weight of 195.9 ± 18.5 SD pounds (range, 154 to 228), and mean body fat percentage of 18.6 ± 3.9 SD % (range, 12.3 to 24.1).

Design: This is a non-experimental descriptive quantitative repeated measures study design. This study was performed at Florida Gulf Coast University (FGCU). Prior to participation, all subjects provided written informed consent. This study was approved by the University institutional review board.

Procedures:

- Data collection was conducted during the first week of the season when the subjects were to pitch in their first game of the season.
- Subjects were positioned supine with the throwing shoulder supported at 90 degrees of abduction and 45 degrees of lateral rotation.
- The elbow was fixed at 30 degrees of flexion as measured by a standard goniometer in order to make the anterior bundle of the UCL the major stabilizer of the elbow.
- Ultrasound images were obtained of the anterior band of the UCL and the medial articulation of the humerus and ulna on the participant's throwing arm using a GE LOGIQ E ultrasound unit (GE Healthcare, Chicago, IL, USA) with a linear probe at 12 MHz One video clip was recorded both at least one hour before and within 10 minutes after the subject pitched.
- 3 kg valgus stress was applied with a handheld dynamometer (Hoggan Scientific microFET 2) 20 cm distal to the medial epicondyle. This fixed distance and resistance was performed to maintain 5 Nm of valgus stress throughout data collection.
- All imaging was performed by a novice student physical therapist with an hour of formal training from a faculty member prior to data collection similar to that performed in Smith.⁷
- Post collection measurements were performed on one image taken from each video clip that provided the most clarity of the following structures. through a caliper function on the GE LOGIQ e was to assess the anterior band, mid-substance thickness, anterior band trochlear attachment thickness, and MJS width.
- Mid-substance measurement was taken between the distal medial epicondyle and superficial common flexor tendon.
- Trochlear attachment measurement was taken between apex of the trochlea and the superficial common flexor tendon.
- MJS distance was measured between the distal edge of the trochlea and the proximal edge of the ulna.
- Three measurements were performed at each site using images taken before and after performance in millimeters (mm).
- The ratio of mid-substance thickness to trochlear thickness was also calculated post collection.

Figure 1: MSKUI Image of the Medial Elbow
MS: mid-substance, AT: apex of the trochlea, MJS: medial joint space



Statistical Analysis

- Data analysis were performed with Version 22 of IBM SPSS software.
- Paired Sample t-tests were performed to compare pre to post mid-substance thickness, pre to post trochlea thickness, pre to post MJS, and pre to post ratio of mid-substance thickness to apex of the trochlea thickness.
- The level of significance was accepted at the P ≤ 0.05 value.

Results

- Results of the Paired Sample t-tests compared average measured width at the mid-substance, apex of the trochlea, and MJS during pre-competition and post-competition.
- Average mid-substance to apex of trochlea ratio was also compared. There were no significant changes in mid-substance, apex of trochlea, and mid-substance to apex of trochlea ratio.
- A statistically significant post-performance change was found in MJS width of approximately 4% in the throwing arm of 10 collegiate pitchers following their first competitive playoff the season.
- When assessing MJS, a significant change of ~4% was observed before (6.30 ± 1.5mm) and after (6.60 ± 1.5mm; p = .005). Controlling for the pitch count [F (1,9) = .17, p = .69] and innings pitched [F (1,9) = .06, p = .81] did not affect the change in MJS.

Table 1: Means, Standard Errors, and 95% CIs for mid-substance, apex of trochlea, MJS width, and mid-substance to apex of trochlea ratio from Pretest to Posttest

	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Mid-substance pretest	5.722	10	.70035	.22147
Mid-substance posttest	5.7	10	.67636	.21388
Apex of trochlea pretest	2.674	10	.65378	.20674
Apex of trochlea posttest	2.614	10	.60766	.19216
MJS width pretest	6.337	10	1.45429	.45989
MJS width posttest	6.584	10	1.54491	.48854
Mid-substance to apex of trochlea ratio pretest	1.00395	10	.03512	.01111
Mid-substance to apex of trochlea ratio posttest	1.02135	10	.05529	.01748

Table 2: Results of Paired Samples t-test for mid-substance, apex of trochlea, MJS width, and mid-substance to apex of trochlea ratio from Pretest to Posttest

	Mean Difference	t value	df	Sig. (2-tailed)
Mid-substance Pretest to Posttest	.022	.362	9	.725
Apex of trochlea Pretest to Posttest	.060	1.298	9	.227
MJS width Pretest to Posttest	-.247	-3.704	9	.005
Mid-substance to apex of trochlea ratio Pretest to Posttest	-.0174	-.745	9	.476

Discussion

Prior to this study, there have been no studies that monitored acute changes following competition in the UCL and MJS width of collegiate pitchers following in-game performance. Changes in MJS may related to increased tissue extensibility due to increased circulation and tissue temperature, but further research of this relationship is needed.

This research study provided additional insight to repeated use trauma in baseball players as others have only conducted long term studies associated with prolonged competition participation.^{5,6} Future research to assess acute changes should include larger sample sizes and conduct data collection at varying times of the season to further explore factors that affect UCL and MJS changes and the degree to which they occur immediately following performance.

Conclusion

This study demonstrated that there is a statistically significant increase in the MJS of the throwing arms of Division I collegiate pitchers following their first competition outing of the season. More investigation may yield details on the physiological changes that may contribute to the development of UCL injuries in the baseball athlete.

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