



CLINICAL RESEARCH

# Ultrasound study of elbow ulnar collateral ligament changes in collegiate baseball players: A pilot study<sup>☆</sup>



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## KEYWORDS

Ulnar collateral  
ligament;  
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**Summary Objective:** To assess changes in elbow ulnar collateral ligament length in college baseball pitchers over the course of a single season.

**Design:** Cohort Feasibility Study.

**Methods:** Diagnostic ultrasound was used to assess both the dominant and non-dominant medial elbow joint space in four pitchers and five fielders and compared to in-game pitching data. Shoulder, elbow, wrist, hip, knee, and ankle range of motion measurements were also taken.

**Results:** Mean trends for both the pitching and fielding groups showed no increases in dominant arm medial elbow joint space. Range of motion (ROM) increases were seen in both groups, and neither ultrasound nor ROM changes correlated to number of pitches thrown.

**Conclusion:** It is feasible that shoulder and hip range of motion changes directly affect stresses at the elbow in baseball pitching (Wilk et al., 2014) (Sauers et al., 2014). Further research is needed to investigate whether UCL injuries are related to increased laxity of the ligament.

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## Introduction

Increased attention has been directed towards the rising prevalence of elbow ulnar collateral ligament (UCL) tears in professional baseball pitchers, as Conte et al. (2001) reported that the rate of UCL injuries in Major League Baseball (MLB) increased 22% between 1995 and 1999. Posner

et al. (2011) found that MLB pitchers had a significantly greater proportion of upper extremity injuries than fielders, and that 26.3% of all upper extremity pitching injuries from 2002 to 2008 were elbow injuries (Posner et al., 2011).

The surgical intervention of UCL tears is a reconstructive procedure commonly known as Tommy John surgery. During an UCL reconstruction, tissue from the patient's palmaris longus, gracilis, hamstring, patella, or Achilles tendon is harvested and used to replace the torn/damaged UCL (Hibberd et al., 2015). According to the [baseballheatmaps.com](http://baseballheatmaps.com) database (WordPress, 2011–2015), there were 8 UCL reconstructions in 1995, 9 in 1999, 15 in 2000, and 20 in 2007 (WordPress, 2011–2015). Although the volume of surgeries stabilized from 2007 through 2011 (15 reconstructions), in 2012 the number of surgeries increased to 35, followed by 19, 30, and 24 in 2013, 2014, and 2015, respectively (WordPress, 2011–2015).

Baseball at the collegiate level also experiences a high rate of elbow injuries (Dick et al., 2007) (McFarland and Wasik, 1998). The National Collegiate Athletic Association (NCAA) baseball injury data from 1988 through 2004 shows that elbow ligament sprains were the most common upper extremity injury, with 78% of these sprains occurring during pitching (Dick et al., 2007). In addition, elbow ligament sprains account for the most common reason that players missed 10 or more days of baseball activities during this time period (McFarland and Wasik, 1998). The website [www.baseballheatmaps.com](http://www.baseballheatmaps.com) also compiles the quantity of Tommy John surgeries performed at the collegiate level, reporting that 62 surgeries have been performed since 2011, whereas there were 27 total surgeries in the 5 previous collegiate seasons between 2006 and 2010 (WordPress, 2011–2015). However, this website database does not specify if these figures account for all levels of collegiate baseball, and thus these statistics could be very conservative given that there is significantly less media reporting of Tommy John surgeries in college pitchers, especially at the lower levels of collegiate baseball where college prospects are often not profiled.

The gold standard treatment for UCL tears in baseball pitchers is surgical reconstruction (Erickson et al., 2014). This is due to the demands of baseball pitching, in which the anterior band of the UCL acts as a major stabilizer of the medial elbow against valgus torques (Davidson et al., 1995) that can reach 91.6 Nm at maximum external rotation (Anz et al., 2010). When this is compared to 33 Nm tensile force capabilities of the UCL (Azar et al., 2000), it is clear that over time pitching can lead to chronic damage and eventually failure of the UCL, requiring reconstructive surgery in order to reestablish stability of the medial elbow. Previous literature has reported the rate of return to pitching in games following UCL reconstruction can range from 67% to 97%, depending on the source as well as the criteria for return to competition (O'Brien et al., 2015) (Osahr et al., 2014) (Makhni et al., 2014). While the return to sport success rates of this surgery is high, there is little agreement in the literature regarding the level of performance once competitive pitching resumes (Keller et al., 2014) (Erickson et al., 2014) (Jiang and Leland, 2014). In a study by Erickson et al. (2014), 179 pitchers returned to MLB pitching in a mean of  $20.5 \pm 9.72$  months, with some

returning as early as 11 months, and others as long as 30 months.

With the alarming increase of UCL tears and reconstructions seen in professional baseball, there has been extensive speculation regarding the cause of this injury, leading to wide ranging research investigating potential factors of UCL injury including fatigue (Grantham et al., 2014), poor pitching mechanics (Aguinaldo and Chambers, 2009), abnormal glenohumeral joint and hip range of motion (Wilk et al., 2014) (Dines et al., 2009) (Garrison et al., 2012) (Tyler et al., 2014) (Sauers et al., 2014) (Robb et al., 2010), and pitch velocity (Bushnell et al., 2010), and these etiological factors have been studied in professional, college, and youth pitchers. However, the majority of these studies are cross sectional (lacking consistency between pitchers), and do not follow subjects over current seasons or across multiple seasons, and therefore do not monitor changes in the UCL longitudinally over time.

One longitudinal study by Ciccotti et al. (2014) performed diagnostic ultrasound with the elbow under a stressed condition on the UCL's of 368 professional pitchers from the same MLB franchise across 10 seasons, with measurements taken at the beginning of spring training each year. Of the 131 pitchers who participated in two or more years of measurements, 35 pitchers had increased UCL laxity upon follow-up measures, with a mean increase of 0.78 mm. This study was unable to find a statistically significant correlation between increased baseline UCL laxity of the dominant arm with future injuries. However, the authors stated that if 5 additional pitchers had experienced UCL laxity, their results would have reached statistical significance. Since measurements were only taken at the beginning of spring training, one limitation of this study is that one is unable to determine what the pitchers did (including how much they threw) over the course of the year. This study also showed that diagnostic ultrasound is a fast, safe method for assessing UCL integrity in a clinical setting as compared to magnetic resonance imaging (MRI) (Ciccotti et al., 2014). Furthermore, Sasaki et al. (2002) had previously established diagnostic ultrasound as a reliable way to assess the elbow UCL via measuring the amount of gapping at the medial joint space, and reported mean interobserver and intraobserver differences in measurements of 0.1 mm when measuring medial joint space gapping in the elbow (Sasaki et al., 2002).

Another important factor to consider when discussing UCL injury is differences in glenohumeral range of motion between the throwing and non-throwing shoulder. Wilk et al. (2014) found that while glenohumeral internal rotation deficits (GIRD) and external rotation deficits were not correlated with elbow injury, pitchers who had greater than a five degree deficit in total rotational motion, or total flexion in the throwing shoulder compared to non-throwing shoulder, were 2.6 and 2.8 times more likely, respectively, to experience an UCL injury. Garrison et al. (2012) also found that total rotation deficits led to UCL injury, while Dines et al. (2009) reported that only GIRD and internal rotation were correlated to UCL injury.

In this current pilot study, both joint range of motion and elbow diagnostic ultrasound were performed at four points during one baseball season on both collegiate pitchers and fielders. Through utilizing diagnostic

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