

# The Elbow is Connected to the Shoulder! A Regression Analysis of Shoulder and Elbow Adaptations in Professional Baseball Pitchers

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**INTRODUCTION:** Pitchers with deficits in total shoulder rotation range of motion (ROM) are 2.6 times more likely to suffer an elbow injury, with deficits in shoulder flexion ROM also causing an increased risk of elbow injury. Despite the previously-reported effects of shoulder ROM on elbow injury, it is currently unclear whether there is a relationship between chronic tissue adaptations of the shoulder and the elbow in baseball pitchers. Therefore, the purpose of this study was to evaluate the relationship between shoulder ultrasound measures (humeral retroversion [HR], posterior capsule thickness [PCT], posterior rotator cuff muscle pennation angle [PA], and muscle thickness [MT]) and ulnar collateral ligament (UCL) ultrasound measures (UCL thickness and ulnohumeral joint gapping with valgus stress) in professional baseball pitchers.

**METHODS:** Right-handed baseball pitchers from a single professional baseball organization were enrolled during 2021 preseason medical evaluations. Pitchers who were not currently healthy and eligible for full sport participation or who underwent upper extremity surgery within the past year were excluded. Left-handed baseball pitchers were also excluded due to previous studies reporting differences in shoulder adaptations between left- and right-hand dominant baseball pitchers. Enrolled baseball pitchers underwent bilateral shoulder and elbow ultrasound examination with previously published and validated ultrasound techniques. Ulnohumeral joint gapping was first measured with 0 Newtons of valgus stress, and measured again with 150 Newtons of valgus stress applied by the Telos device, with the difference in joint gapping from stressed to unstressed calculated for statistical analysis. Bilateral differences in every included measure were calculated and used for analysis as accounting for the non-dominant upper extremity more closely isolates chronic adaptations. Two multivariate stepwise regressions were performed to determine whether the various shoulder measures were related to 1) UCL thickness and 2) ulnohumeral joint gapping with valgus stress.

**RESULTS:** Overall, 40 right-handed professional baseball pitchers were included. A significant positive relationship was observed between chronic adaptations of UCL thickness and PCT ( $R=0.344$ ,  $R^2=0.118$ ,  $p=0.030$ ) (Table 1). Adaptations of HR and posterior rotator cuff PA and MT were not significantly related to UCL thickness (Table 2). There were no statistically significant relationships between chronic adaptations of the shoulder and ulnohumeral joint gapping.

**DISCUSSION AND CONCLUSION:** Chronically the UCL adapts in conjunction with the posterior capsule; in other words, as the repetitive stress of pitching causes the posterior capsule to become thicker the UCL thickens as well. Previous research has demonstrated that UCL thickness does progress over time and may be a surrogate to detrimental structural adaptations. Future research is currently underway to demonstrate whether increases in UCL thickness correspond to decreased structural properties.

**Table 1.** Multivariate stepwise regression to determine whether chronic adaptations of the shoulder are related to adaptations of ulnar collateral ligament (UCL) thickness.

Predictor	R <sup>2</sup>	Unstandardized $\beta$	Standard Error	Standardized $\beta$	t
Model 1	0.118				
PCT		1.882	0.834	0.344	2.257
Constant		1.337	0.431		3.104

PCT=posterior capsule thickness.

**Table 2.** Pearson correlation analyses determining the univariate relationships between chronic adaptations of various shoulder measures and the ulnar collateral ligament (UCL) thickness.

Shoulder Variable	Correlation Coefficient (R)	P value
Humeral Retroversion	-0.025	0.440
Posterior Capsule Thickness	0.344	<b>0.015</b>
Superficial Infraspinatus PA	0.126	0.219
Deep Infraspinatus PA	-0.148	0.181
Infraspinatus MT	0.003	0.492
Superficial Teres Minor PA	0.232	0.075
Deep Teres Minor PA	-0.114	0.242
Teres Minor MT	-0.078	0.316

PA=pennation angle, MT=muscle thickness. Statistically significant p-values are bolded.