The Utility of Stress Ultrasound in Identifying Risk Factors for Elbow Ulnar Collateral Ligament Rupture: A Longitudinal Study of 203 Professional Baseball Players

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INTRODUCTION:

Injuries to the medial ulnar collateral ligament (UCL) are common among baseball pitchers due to repetitive stress on the soft tissue stabilizers of the elbow during pitching. Dynamic stress ultrasound (SUS) can be used for evaluation of the UCL and ulnohumeral joint in order to identify anatomic risk factors of those who will require UCL reconstruction (UCLR). This study aimed to compare the stress ultrasound findings between pitchers who did and did not require UCL reconstruction procedures and to assess for significant differences that predispose players to future injury. Our hypothesis was that there would be significant differences in the SUS findings of players who undergo UCLR compared to those who do not undergo UCLR.

METHODS:

A total of 203 professional baseball pitchers with dynamic SUS performed at pre-season training sessions over an 18-year period were identified. Medical histories were reviewed and players were categorized into one of two groups, those with no history of upper extremity surgery or injuries ('Healthy' cohort n=184) and those who underwent UCL reconstruction (UCLR, n=19) the same season as SUS and with no history of previous injuries or surgeries ('UCLR' cohort). SUS findings including ligament thickness, joint spacing and laxity were compared between groups. Additional analysis was run to detect if there was any difference in the progression of UCL and ulnohumeral joint measures in the year prior to injury. Players in the UCLR cohort (n=10) were matched to a cohort of 'healthy' pitchers (n=10) by arm dominance, age, and player experience.

RESULTS:

Median age of pitchers in the healthy cohort were significantly higher than age of those in the UCLR cohort (23 years vs. 22 years, P=0.004). Those in the UCLR group had high detected rates of hypoechoic foci (57.9% vs. 30.4%, P=0.030) as well as higher median relative ulnohumeral joint rest space (0.50mm vs. 0.20mm, P=0.006) than those in the healthy cohort. Progression data in the year leading to surgery revealed those in the UCLR group saw a mean increase in dominant arm UCL thickness of 0.94mm compared to a 0.60mm decrease in thickness in the matched healthy cohort over the same period (P=0.038). Likewise, data showed a median increase of 1.35mm relative UCL thickness in the UCLR cohort compared to a median 0.35mm decrease in the healthy cohort (P=0.045). However, other progression data revealed no difference between groups in the progression of ulnohumeral joint spacing or laxity in the dominant, nondominant, or relative measurements in the year leading up to surgery.

DISCUSSION AND CONCLUSION: Players requiring UCL reconstruction had greater detected ulnohumeral joint rest space and higher rates of hypoechoic foci detected on SUS than those who did not require UCLR. Additionally, these players had a greater increase in dominant arm UCL thickness and relative UCL thickness compared to players who did not require UCLR. It is possible these may indicate possible anatomic risk factors for UCL injuries.

	Total Data (n=203)	Healthy (n=184)	UCLR (n=19)	P Value
Dominant Side Measurements				
UCL Thickness (mm)	5.60 [4.65;7.00]	5.50 [4.57;6.82]	6.00 [5.30;7.50]	0.161
Rest Space (mm)	2.90 [2.50;3.50]	2.90 [2.50;3.50]	3.10 [2.55;3.55]	0.321
Stress Space (mm)	3.70 [3.20;4.60]	3.70 [3.18;4.60]	4.00 [3.40;4.60]	0.498
Laxity (mm)	0.80 [0.30;1.25]	0.80 [0.30;1.22]	0.70 [0.20;1.30]	0.796
Non-Dominant Side Measurements				
UCL Thickness (mm)	4.00 [3.40;4.80]	4.00 [3.40;4.80]	4.00 [3.45;4.60]	0.928
Rest Space (mm)	2.80 [2.40;3.20]	2.85 [2.48;3.23]	2.60 [2.25;3.00]	0.119
Stress Space (mm)	3.40 [2.95;4.00]	3.40 [3.00;4.00]	3.10 [2.70;3.70]	0.281
Laxity (mm)	0.50 [0.20;0.90]	0.50 [0.10;0.90]	0.40 [0.20;0.90]	0.558

Table 1. Stress Ultrasound measurements from dominant and nondominant sides of players who underwent UCLR the same season as measurement (UCLR group) and those who did not undergo UCLR (No-UCLR group). UCL = Ulnar Collateral Ligament, Median [1st quartile; 3rd quartile]

	Total Data (n=203)	Healthy (n=184)	UCLR (n=19)	P Value
Dominant Side Measurements				
Calcifications Present	51 (25.1%)	49 (26.6%)	2 (10.5%)	0.167
Size of Calcifications (mm)	4.66 (1.99)	4.56 (1.93)	6.25 (3.18)	0.590
Hypoechoic Foci Present	67 (33.0%)	56 (30.4%)	11 (57.9%)	**0.030***
Osteophytes Present	42 (20.7%)	40 (21.7%)	2 (10.5%)	0.375
Tears Present	3 (1.48%)	3 (1.63%)	0 (0.00%)	1.000

Table 2. Stress Ultrasound measurements from dominant sides of players who underwent UCLR the same season as measurement (UCLR group) and those who did not undergo UCLR (Healthy Group). UCLR = Ulnar Collateral Ligament Reconstruction, No (%),Median [1st quartile; 3rd quartile]

	Total Data (n=203)	Healthy (n=184)	UCLR (n=19)	P Value
Relative UCL Thickness (mm)	1.50 [0.55;2.85]	1.40 [0.50;2.62]	2.20 [1.25;3.65]	0.098
Relative Rest Space (mm)	0.20 [-0.35;0.70]	0.20 [-0.40;0.60]	0.50 [0.30;0.80]	**0.006***
Relative Stress Space (mm)	0.40 (0.97)	0.36 (0.98)	0.74 (0.84)	0.081
Relative Laxity (mm)	0.20 [-0.20;0.80]	0.15 [-0.20;0.90]	0.20 [-0.25;0.60]	0.687

Table 3. Relative stress ultrasound measurements comparing differences in dominant and non-dominant side measurements in players who underwent UCLR the same season as measurement (UCLR group) and those who did not undergo UCLR (Healthy Group). UCLR = Ulnar Collateral Ligament Reconstruction, Median [1st quartile; 3rd quartile], Mean (SD)

	Total Data (n=20)	Healthy (n=10)	UCLR (n=10)	P Value
Dominant Side Measurements				
Progression of UCL Thickness (mm)	0.17 (1.66)	-0.60 (0.94)	0.94 (1.90)	**0.038***
Progression of Rest Space (mm)	0.44 (0.76)	0.75 (0.84)	0.12 (0.54)	0.064
Progression of Stress Space (mm)	0.27 (1.34)	0.71 (1.37)	-0.17 (1.22)	0.148
Progression of Laxity (mm)	-0.11 (0.95)	0.06 (0.90)	-0.29 (1.02)	0.425
Non-Dominant Side Measurements				
Progression of UCL Thickness (mm)	4.00 [3.40;4.80]	4.00 [3.40;4.80]	4.00 [3.45;4.60]	0.928
Progression of Rest Space (mm)	2.80 [2.40;3.20]	2.85 [2.48;3.23]	2.60 [2.25;3.00]	0.119
Progression of Stress Space (mm)	3.40 [2.95;4.00]	3.40 [3.00;4.00]	3.10 [2.70;3.70]	0.281
Progression of Laxity (mm)	0.50 [0.20;0.90]	0.50 [0.10;0.90]	0.40 [0.20;0.90]	0.558
Relative Measurements				
Progression of Relative UCL Thickness (mm)	0.05 [-0.58;1.35]	-0.35 [-0.73;0.08]	1.35 [0.05;1.95]	**0.045***
Progression of Relative Rest Space (mm)	0.54 (0.62)	0.66 (0.64)	0.43 (0.61)	0.422
Progression of Relative Stress Space (mm)	0.44 (1.34)	0.80 (1.44)	0.07 (1.19)	0.233
Progression of Relative Laxity (mm)	-0.06 (1.30)	0.24 (1.23)	-0.36 (1.36)	0.315

Table 4. Comparison of dominant, nondominant arm, and relative stress ultrasound progression measurements. For relative measurements, a positive value indicates that the dominant arm UCL saw a relative increase in thickness/rest space/stress/laxity space during the study period compared to the non-dominant arm. Mean (SD), Median [1st quartile; 3rd quartile]
UCL = Ulnar Collateral Ligament
UCLR = Ulnar Collateral Ligament Reconstruction,