Conclusions: Endoscopic or open distal biceps re-attachments are safe procedures as long as the surgical dissection does not cross the proximal 1/3 of the olecranon-radial styloid reference line with the forearm in neutral rotation. Forearm neutral and pronated positions increase the distance between the distal portal and PIN. We recommend that the distal portal be positioned at 30% of the olecranon-radial styloid (ORS) reference line with the forearm in neutral or pronation (Table 1).

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Paper #8 INDOMETHACIN PROPHYLAXIS DOES NOT REDUCE THE RISK OF HETEROTOPIC OSSIFICATION FOLLOWING A TWO-INCISION DISTAL BICEPS REPAIR

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Background: Use of heterotopic ossification (HO) prophylaxis remains controversial following a distal biceps repair.

Hypothesis: There will be a reduction in HO in patients treated with indomethacin (INDO)

Methods and Materials: A retrospective review of all patients who underwent a two-incision distal biceps repair was performed. Inclusion criteria included: age >18, direct two-incision repair with at least 6 months follow-up. Patient demographic information as well as time from injury to surgery, tourniquet time, tobacco use, and development of HO was recorded. Patients who were prescribed any anti-inflammatory non-steroidal medications identified and the medical record was reviewed to confirm the compliance of INDO.

Results: Of 146 patients who met our inclusion criteria, 45 (30.8%) had a post-operative radiograph, 14 (31.1%) treated with INDO for a mean of 6.7 weeks (range: 2 to 12 weeks), and 31 (68.8%) without (Controls). There was a difference in age between INDO and controls (41 vs 51 years, $P < .01$), but no difference in time from injury to surgery (43 vs 21 days, $P = .62$), tourniquet time (75 vs. 72 minutes, $P = .66$), or percentage of smokers ($P = .958$). 6 Of 14 (42.9%) INDO patients developed HO/SO and 7 of 31 (22.6%) controls developed HO ($P = .16$). In an age-adjusted logistic regression model, use of INDO was associated with 8.20 (95% CI: 1.28, 52.34) times higher odds of developing HO. There was no difference in low versus high dose ($P = .63$) or length of treatment ($P = .69$).

Conclusion: Although not statistically significant, there was an 8 times higher odds of developing HO when patients were treated with INDO after a two-incision distal biceps repair. No difference was noted in dosage, nor duration of treatment. We feel that prophylaxis is not warranted and can actually increase risk of HO following a two-incision repair.

Keywords: distal biceps, two incision, prophylaxis, indomethacin, heterotopic ossification, synostosis

Paper #9 DELAYED MANAGEMENT OF DISTAL BICEPS RUPTURE: RECONSTRUCTION WITH SEMITENDINOSIS AUTOGRAFT VERSUS PRIMARY REPAIR

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Background: Delayed presentation of distal biceps ruptures can make primary repair impossible, in which case reconstruction using a graft is an option. The current literature includes a variety of techniques with reconstruction studies reporting small patient numbers but no comparison to delayed direct repair has been made. The aim of this study was to compare functional outcomes, patient satisfaction and complications between delayed direct repair (>21 days) and reconstruction with a semitendinosis autograft.

Methods: Nineteen delayed distal biceps rupture cases treated with a tendon reconstruction were compared to sixteen delayed primary repair cases (>21 days). The reconstructions were performed using a semitendinosis autograft through a bone tunnel in the radius and a pulvertaft weave into the remnant distal biceps tendon and muscle. The patient cohorts were reviewed and completed functional outcomes testing including range-of-motion, supination and isometric elbow flexion strength, Disabilities of the Arm, Shoulder and Hand questionnaire; Patient-Reported Elbow Evaluation, Single Assessment Numeric Evaluation, and Mayo Elbow Performance Score.

Results: Mean patient age was 46 ± 8 years in the reconstruction cohort versus 49 ± 9 years in the delayed repair cohort. Mean duration of follow-up was 45 ± 27 months in the reconstruction cohort versus 47 ± 25 months in the delayed cohort. The time from injury to surgery averaged 266 ± 248 days in the reconstruction cohort versus 37 ± 12 days in the delayed repair cohort. Range of motion, supination strength and elbow flexion strength were similar between cohorts ($P = .62$, $P = .26$, $P = .93$ respectively). The average maximum elbow extension achieved in the operating room after delayed primary repair was 48 ± 22° vs. 57 ± 18° for the reconstruction cohort ($P = .12$). The mean postoperative Disabilities of the Arm, Shoulder and Hand questionnaire, and the Single Assessment Numeric Evaluation were similar between the cohorts ($P = .08$, $P = .22$ respectively). The Patient-Rated Elbow Evaluation, and the Mayo Elbow Performance Index were better in the delayed repair cohort compared to the reconstruction cohort (3.6 ± 4.5 versus 13.8 ± 19.1, $P = .02$, and 95.3 ± 7.2 versus 85.8 ± 13.7, $P = .04$ respectively). Complications were similar between cohorts ($P = .87$). The most common complication was transient lateral antebrachial cutaneous nerve palsy in four patients (21%) in the reconstruction cohort and six patients (38%) in the delayed repair cohort lasting beyond 6 months. One patient (5%) in the reconstruction group had an early graft failure at the muscle-tendon graft interface.

Conclusion: Delayed reconstruction of irreparable distal biceps ruptures with semitendinosis autograft produces similar strength, range of motion and complication rates but slightly worse functional outcome scores compared with delayed primary repair. Despite placing the elbow into high degrees of flexion at the end of primary repair and reconstruction, this did not impede final range of motion, strength or functional outcome scores.

Paper #10 ASYMPTOMATIC MRI FINDINGS OF THE ELBOW PREDICT INJURY AND SURGERY IN MAJOR LEAGUE BASEBALL PITCHERS

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Background: Repetitive pitching produces significant stresses onto the elbow that produce structural abnormalities discernable on Magnetic Resonance Imaging (MRI) without causing symptoms. It is unknown whether these structural abnormalities pose any long term clinical significance. The purpose of this study is to determine whether there exists an association between subclinical MRI findings in asymptomatic elbows in major league baseball pitchers, and future placement on the disabled list or future surgery.

Methods: All major league pitchers undergoing routine pre-signing imaging at a single organization were retrospectively reviewed

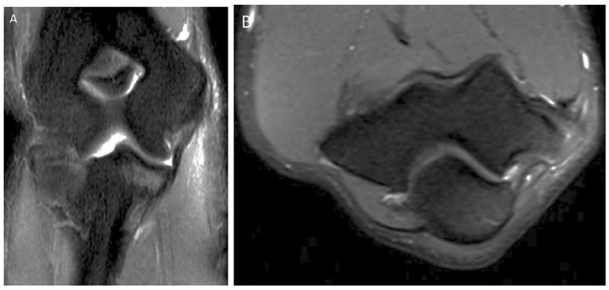

Figure 1 (A) Coronal slide of T2-weighted MRI image demonstrating (A) ulnar collateral ligament hyperintensity and (B) radiologic posteromedial impingement in two professional MLB pitchers.

from 2005 – 2017 for MRI images of their pitching elbow. Publically available databases were queried to exclude pitchers with injury prior to earliest elbow MRI. Three blinded reviewers, reviewed all MRI studies independently to evaluate for presence of chondral damage of the joint, loose bodies, UCL heterogeneity or tear, flexor pronator mass defect, and signs of posteromedial impingement. Binary imaging findings were related to future placement on the disabled list (DL) for elbow complaints and future elbow surgery.

Results: A total of 41 pitchers had asymptomatic MRI imaging with no prior DL placement. Average age of pitchers was 28.9 ± 4.6 and average career games was 115.0 ± 132.8. For players who eventually went on the DL, there were a statistically greater number of players with heterogeneous signal of the ulnar collateral ligament ($P = .021$), humeral sided partial tearing of the ulnar collateral ligament ($P = .031$), and posteromedial impingement ($P = .004$) on pre-injury MRI in comparison to players that remained healthy. Pitchers that were placed on the DL spent an average of 123.1 ± 69.7 days only due to elbow-related injuries. Pitchers with UCL heterogeneity were associated with reduced career strike zone percentage, innings pitched, and fastball percentage.

Conclusion: This study demonstrates that UCL heterogeneity, posterior medial impingement and humeral-sided partial tears are correlated with future placement on the DL in MLB pitchers. In addition, asymptomatic posteromedial impingement may be a precursor to future surgery. Overall, this data may prove useful for coaches, trainers and team physicians to appropriately risk stratify new players and establish preventative algorithms to prevent the overall impact of these elbow injuries (Fig. 1).

Paper #11 RISK FACTORS FOR ULNAR COLLATERAL LIGAMENT INJURY IN PROFESSIONAL AND AMATEUR BASEBALL PLAYERS: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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Background: Ulnar collateral ligament injury (UCLI) risk factors are unclear despite increasing injury rates.

Hypothesis/Purpose: Summarize UCL injury risk factors across professional and amateur baseball players.

Study Design: Systematic review and meta-analysis

Methods: A computer-assisted search of four databases was performed utilizing keywords related to UCLI risk factors. The *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) guidelines were utilized for study methodology. Odds ratio and 95% confidence interval (CI) were calculated for dichotomous outcomes, while mean differences and 95% CI were calculated for continuous outcomes using a random effects model. Risk of bias of the included studies was assessed using the modified Downs & Black grading tool.

Results: Of the 1255 identified studies, 13 qualified for inclusion. Greater shoulder internal rotation (IR) range-of-motion (ROM) at 90° abduction in the non-dominant (ND) arm demonstrated *strong evidence* as a significant risk factor for UCLI ($P < .001$) when compared to a control group [mean difference 6.2 (95% CI: 3.8 to 8.6). Mean pitching fastball ($P = .0003$) [mean difference 0.6 (95% CI: 0.29 to 1.00), changeup ($P = .03$) [mean difference 0.49 (95% CI: 0.04 to 0.94), curveball ($P = .01$) [mean difference 0.78 (95% CI: 0.18 to 1.38), and overall ($P < .001$); [mean difference 0.90 (95% CI: 0.86 to 0.94); I^2=0%] pitching velocity; as well as fewer years of player experience ($P < .00001$) [mean difference –1.19 (95% CI: –1.41 to –0.96), less humeral retrotorsion in the ND arm ($P = .0009$) [mean difference 5.4 (95% CI: 2.2 to 8.5), and greater absolute side-to-side differences in retrotorsion ($P = .006$) [mean difference 6.2 (95% CI: 1.83 to 10.68) were all *moderate evidence* risk factors when compared to control groups. *Strong evidence* suggests total ROM arc in 90° abduction in dominant arm was not a risk factor for UCLI ($P = .81$) [mean difference –1.0 (95% CI: –9.4 to 7.3); I^2=81%].

Conclusions: Greater ND shoulder IR ROM and less humeral retrotorsion (in professional and amateur players), as well as pitching velocity (in professional players) demonstrated strong to moderate evidence as risk factors for UCLI. Dominant arm total arc of motion, external, or internal ROM were not risk factors for UCLI. Standardized collection and reporting of risk factors is recommended to more clearly elucidate definitive risk factors for UCLI.

Clinical Relevance: Clinicians should consider educating coaches, parents, and players of the potential risk of increased pitching velocity relative to incidence of UCLI. Clinicians should also consider assessment of ND shoulder internal ROM and humeral retrotorsion relative to UCLI risk, but also realize UCLI are multi-factorial and simply focusing on ROM/torsion is not the key to prevention of these injuries.

What is Known About the Subject: UCLI and subsequent UCL surgery prevalence is increasing at all levels of baseball. Many risk factors have been described across various levels of evidence without a systematic consensus of the published literature.

What this Study Adds to Existing Knowledge: To our knowledge, this is the first systematic review with meta-analysis of published risk factors for UCLI. We stratify UCLI risk factors into significant and non-significant risk factors. Additionally, we utilize risk of bias assessment to provide evidence-based strength of evidence for the included recommendations (e.g. strong, moderate, limited, very limited and conflicting evidence).

Paper #12 REVERSE SHOULDER ARTHROPLASTY WITH AND WITHOUT CONCOMITANT LATISSIMUS DORSI AND TERES MAJOR TRANSFER FOR SHOULDER PSEUDOPARALYSIS WITH TERES MINOR DYSFUNCTION: A PROSPECTIVE, RANDOMIZED INVESTIGATION

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Institution at which the work was performed: OrthoCarolina Shoulder & Elbow Center and Atrium Healthcare.