

Paper 01:

Abstract Title:

A Comparison of Anatomic Double and Single-bundle Techniques for Anterior Cruciate Ligament Reconstruction, A Prospective Randomized Study with a 5-year Follow-up

Authors:

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³Development of Research and Development, USA, ⁴Skaraborg Hospital, Lidköping, Sweden, ⁵Norra Dlivsborgs Ldnssjukhus, Trollhattan, Sweden.

Objectives: The purpose of this study was to compare the mid-term outcome after arthroscopic anterior cruciate ligament (ACL) reconstruction with either the anatomic double-bundle (DB) or anatomic single-bundle (SB) technique using hamstring tendon autografts in an unselected group of patients.

Methods: 103 patients (33 women, 70 men; median age, 27 years; range, 18-52 years) were randomized and underwent ACL reconstruction (DB group; n=53 and SB group; n=50). All reconstructions were performed anatomically, identifying the ACL footprints, using the anteromedial portal for the femoral tunnel drilling and utilizing interference screw for tibial and femoral fixation. One blinded observer examined the patients both preoperatively and at follow-up (median, 64 months; range, 55-75 months). Radiographic evaluation of OA was performed using the Ahlbäck, Kellgren-Lawrence and Fairbanks grading systems in the early postoperative period and at follow up.

Results: Preoperatively, no differences were found between the study groups apart from the pre-injury Tegner activity level, which was lower in the DB group ($p=0.02$). Eighty-seven patients (83%) were available for examination at 5-year follow-up. There were no significant differences between the groups in terms of the pivot-shift test, KT-1000 arthrometer laxity measurements, manual Lachman test, One-leg-hop test, Square-hop test, range of motion, Lysholm knee scoring scale, Tegner activity scale and Knee Injury and Osteoarthritis Outcome Score (KOOS). Correspondingly, no differences were found between the groups regarding the presence of OA at follow-up. Both DB and SB groups improved significantly at follow-up compared with the preoperative assessment.

Conclusion: At mid-term follow-up of an unselected group of patients, anatomic DB reconstruction was not superior to anatomic SB reconstruction in terms of the pivot-shift test or subjective and objective outcome variables, as seen in this prospective randomized study. Furthermore, there was no difference in terms of the presence of OA at follow-up.

Paper 02

Abstract Title:

Increased Risk of Revision after ACL Reconstruction with Soft Tissue Allograft Compared to Autograft: Graft Processing and Time Make a Difference.

Authors:

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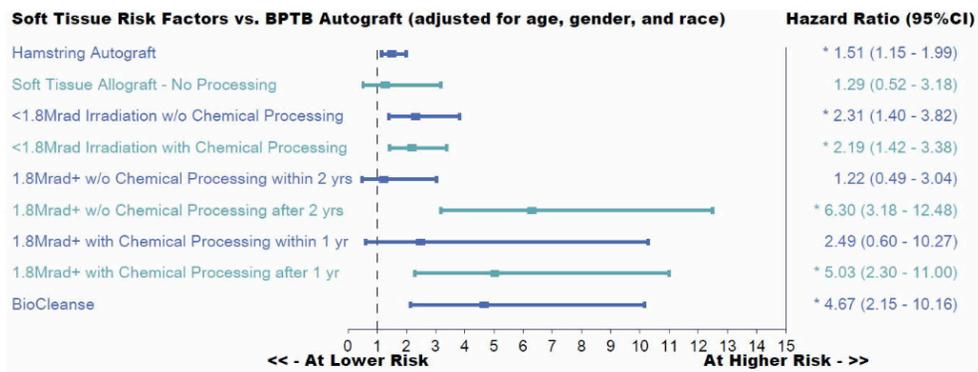
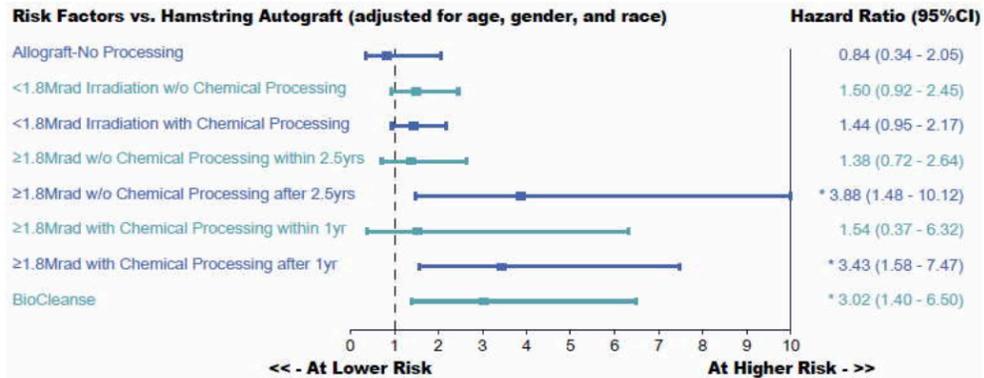
Objectives: The use of allograft tissue for anterior cruciate ligament reconstruction (ACLR) remains controversial. Numerous meta-analysis and systematic reviews of small clinical studies have not found differences between autograft and allograft outcomes but large registry studies have shown an increased risk of revision with allografts. The purpose of this study was to compare the risk of aseptic revision between bone-patellar tendon-bone (BPTB) autografts, hamstring tendon autografts and soft tissue allografts.

Methods: A retrospective cohort study of prospectively collected data was conducted using an US ACLR Registry. A cohort of primary unilateral ACLR cases reconstructed with BPTB autografts, hamstring autografts and soft tissue allografts (from any site) was identified. Aseptic revision was the end point of the study. Type of graft and allograft processing methods (non-processed, <1.8Mrads with and without chemical processing (Allowash or AlloTrue methods), ≥1.8 Mrads irradiation with and without chemical processing, and chemical processing alone (BioCleanse)) were the exposures of interest evaluated. Time from surgery was evaluated as an effect modifier. All analyses were adjusted for age, gender, and race. Kaplan-Meier curves and Cox proportional hazard models were employed. Hazard ratios (HR), 95% confidence intervals (CI) are provided.

Results: The cohort had 14015 cases, 8924 (63.7%) were male, 6397 (45.6%) were White, 4557 (32.5%) cases used BPTB autograft, 3751 (26.8%) cases used soft tissue allograft and 5707 (40.7%) cases used hamstring autograft. The median age was 34.6 years-old (IQR 24.1-43.2) for allograft cases and 24.3 years-old (IQR 17.7-33.8) for hamstring autograft cases, and 22.0 years-old (IQR 17.6-30.0) for BPTB autograft cases. Compared to hamstring tendon autografts, an increased risk of revision was found in allografts processed with ≥1.8Mrads without chemical processing after 2.5 years (HR: 3.88 95%CI 1.48-10.12), and ≥1.8Mrads with chemical processing after only 1 year (HR: 3.43 95%CI 1.58-7.47) and with BioCleanse processed grafts (HR: 3.02 95%CI 1.40-6.50). Compared to BPTB autografts, an increased risk of revision was seen with hamstring autografts (HR: 1.51 95%CI 1.15-1.99) and BioCleanse processed allografts (HR: 4.67 95%CI 2.15-10.16). Allografts irradiated with <1.8 Mrads with chemical processing (HR: 2.19 95%CI 1.42-3.38) and without chemical processing (HR: 2.31 95%CI 1.40-3.82) had a higher risk of revision as did allografts with ≥ 1.8Mrads without chemical processing after 2.0 years (HR: 6.30 95%CI 3.18-12.48) and ≥1.8 Mrads with chemical processing after 1 year (HR: 5.03 95%CI 2.30-11.0). Non-processed soft tissue allografts did not have a higher risk of revision when compared to hamstring or

BPTB autografts.

Conclusion: When soft tissue allografts are used for ACLR, both processing and time from surgery affect the risk of revision when compared to autografts. Tissue processing has a significant effect on the risk of revision surgery and that effect is most profound with more highly processed grafts and increases with time. Surgeons and patients need to be aware of the increased risks of revision with the various soft tissue allograft used for ACLR.



Paper 03

Abstract Title:

Surgical Predictors of Clinical Outcome following Revision ACL Reconstruction

Authors:

Rick W. Wright, MD¹, Mars Group².

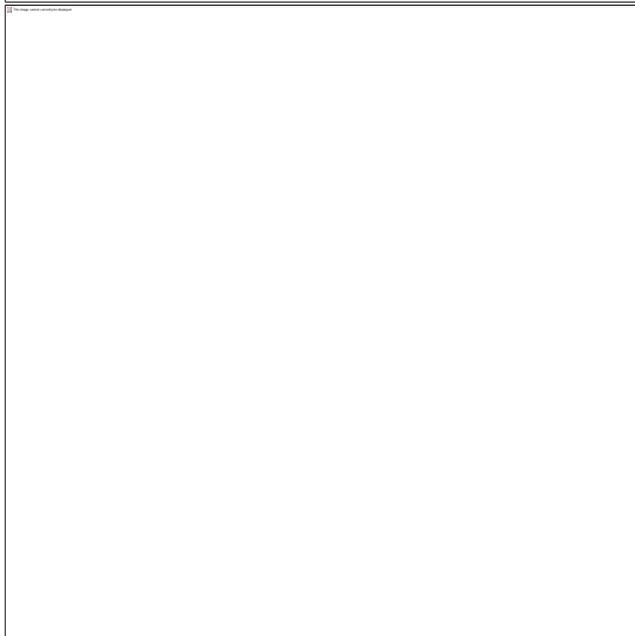
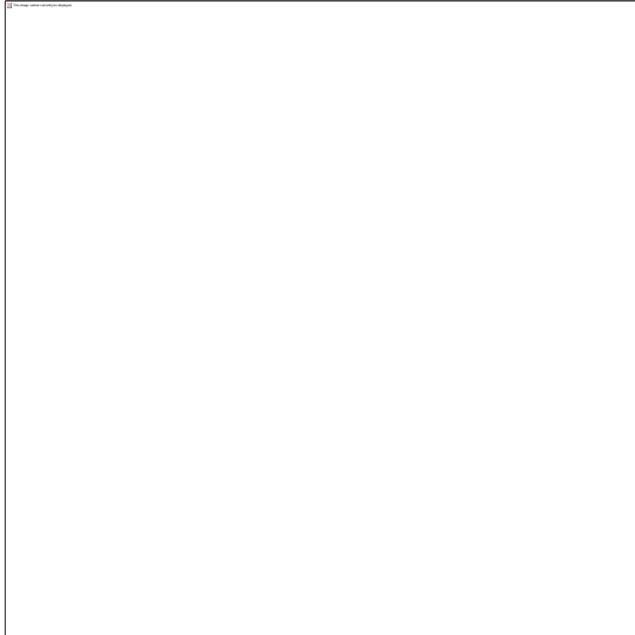
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Objectives: Revision ACL reconstruction has been documented to have worse outcomes compared with primary ACL reconstructions. The reasons why remain unknown. The purpose of this study was to determine either previous or current surgical factors noted at the time of ACL revision reconstruction predicts activity level, sports function, and OA symptoms at two year follow-up.

Methods: Revision ACL reconstruction patients were identified and prospectively enrolled between 2006 and 2011. Data collected included baseline demographics, surgical technique and pathology, and a series of validated patient reported outcome instruments (IKDC, KOOS, WOMAC, and Marx activity rating score). Patients were followed up for 2 years, and asked to complete the identical set of outcome instruments. Regression analysis was used to control for age, gender, BMI, activity level, baseline outcome scores, revision number, time since last ACLR, and a variety of previous and current surgical variables, in order to assess the surgical risk factors for clinical outcomes 2 years after revision ACL reconstruction.

Results: 1205 patients met the inclusion criteria and were successfully enrolled. 697 (58%) were males, with a median cohort age of 26 years. The median time since their last ACL reconstruction was 3.4 years. Baseline characteristics of the cohort are summarized in Table 1. At 2 years, follow-up was obtained on 82% (989/1205). Both previous as well as current surgical factors were found to be significant drivers of poorer outcomes at 2 years (Table 2). The most consistent surgical factors driving outcome in revision patients were prior surgical technique, prior tibial tunnel position, current femoral fixation and having a notchplasty. Having a previous arthrotomy compared to the one incision technique resulted in significantly poorer outcomes on the IKDC (odds ratio=0.41; 95% CI=0.17-0.95; p=0.037) and KOOS pain, sports/rec, and QOL subscales (OR range=0.23-0.42; 95% CI=0.10-0.97; p≤0.05). Using a metal interference screw for current femoral fixation resulted in significantly better outcomes in 2 year KOOS symptoms, pain, and QOL subscales (OR range = 0.51-0.59; 95% CI=0.30-1.00; p≤0.05), as well as WOMAC stiffness (OR=0.57; 95% CI=0.33-0.98; p=0.041). Avoiding a notchplasty significantly improved 2 year outcomes of the IKDC (OR=1.47; 95% CI=1.08-1.99; p=0.013), KOOS ADL and QOL subscales (OR range = 1.40-1.41; 95% CI=1.03-1.93; p≤0.04), and the WOMAC stiffness and ADL subscales (OR range = 1.41-1.49; 95% CI=1.03-2.05; p≤0.04). Lower baseline outcome scores, activity level, higher BMI, female gender, and shorter time since the patient's last ACL reconstruction all significantly increased the odds of reporting poorer clinical outcomes at 2 years. Prior femoral fixation, prior femoral aperture position, and the knee flexion angle at the time of graft fixation were not found to be significant risk factors for 2 year outcomes in this revision cohort.

Conclusion: There are surgical variables that the physician can control at the time of an ACL revision which have the ability to modify clinical outcomes at 2 years. Whenever possible, opting for an anteromedial portal or transtibial surgical exposure, choosing a metal interference screw for femoral fixation, not performing a notchplasty, and not using a biologic enhancement will improve the patient's odds of having a significantly better 2 year clinical outcomes.



Paper 04

Abstract Title:

Pre-operative Lumbar Plexus Block Provides Superior Post-operative Analgesia when Compared with Fascia Iliaca Block or General Anesthesia Alone in Hip Arthroscopy

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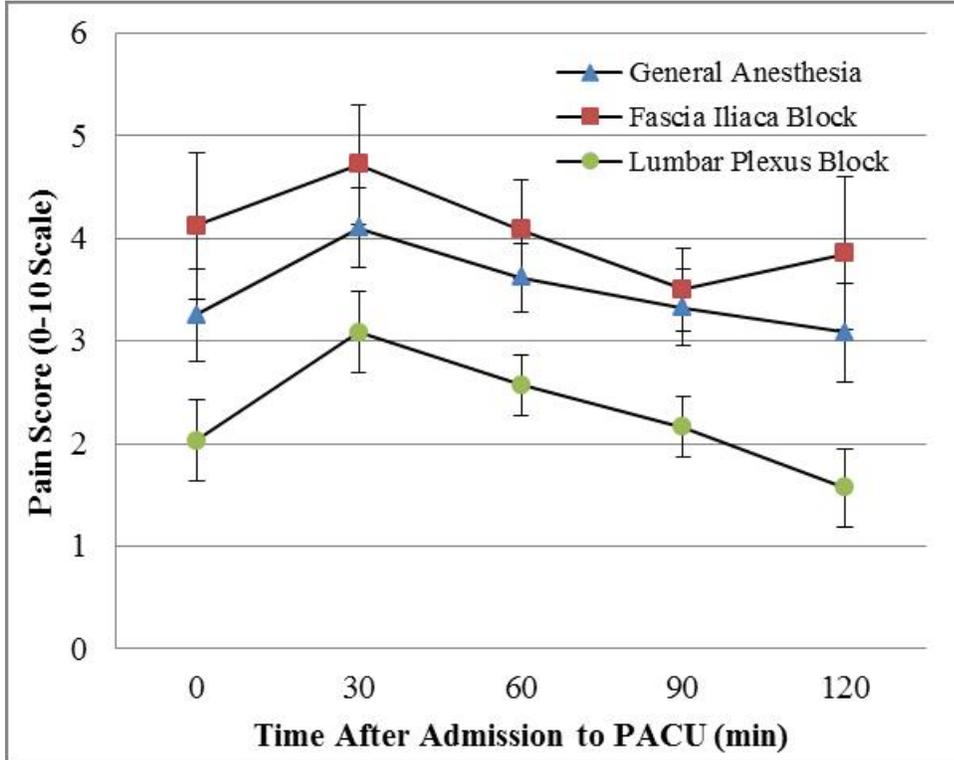
Objectives: Nerve block administration in concert with general anesthesia can help manage post-operative pain and provide favorable muscle relaxation of the operative leg in hip surgery. However, the optimal nerve blockade, if any, for arthroscopic surgery of the hip remains undefined. Considerations specific to hip arthroscopy include control of intra-operative pain, adequate muscle relaxation to allow for distraction for work in the central compartment, and post-operative pain control. Dold et al. recently reported in *AJSM* that a pre-operative femoral nerve block administered in concert with general anesthesia led to decreased patient-reported pain scores at the 60 minute mark post-operatively. Given this demonstrated benefit of the pre-operative femoral nerve block, we hypothesized that a regional block that anesthetized the femoral nerve and the lateral femoral cutaneous nerve (as the fascia iliaca block does), or one that anesthetized the obturator nerve in addition to the femoral and lateral femoral cutaneous nerves (i.e. the lumbar plexus block), would provide additional benefit. The purpose of this study is to examine the effects of pre-operative fascia iliaca and lumbar plexus nerve blocks on post-operative pain and secondary post-operative variables following arthroscopic surgery of the hip.

Methods: A retrospective chart analysis was conducted on 145 patients undergoing arthroscopic surgery of the hip in 3 groups. Group 1 (n=55) received general anesthesia only, Group 2 (n=30) received general anesthesia and a fascia iliaca nerve block, and Group 3 (n=60) received general anesthesia and a lumbar plexus nerve block. Post-operative measures were recorded, examined and compared. The primary outcome measure was patient reported pain scores (0-10) at 0, 30, 60, 90 and 120 minutes in the post-anesthesia care unit (PACU). Secondary variables examined included time spent in the PACU, morphine equivalent administered, and presence of nausea requiring anti-emetic medication.

Results: Mid-term analysis revealed no benefit to the fascia iliaca block; this regional anesthesia technique showed no significant effect on any of the measured post-operative variables when compared to general anesthesia alone. We therefore abandoned this block in favor of the lumbar plexus block. Patients receiving a lumbar plexus block exhibited significantly decreased pain at each time point when compared to the fascia iliaca group, and at all but one time point when compared to the general anesthesia group ($P < 0.05$). There was no difference in the time spent in the PACU, nor in morphine equivalent administered between any of the groups.

Conclusion: The results of the current study indicate that for arthroscopic surgery of the hip, a pre-operative lumbar plexus regional block performed in conjunction with general anesthesia provides

significant and clinically meaningful decreases in post-operative pain reported in the PACU when compared with general anesthesia alone or general anesthesia with fascia iliaca block. This relative benefit we found in our lumbar plexus block patients is likely attributable to the more complete and proximal nervous blockade afforded by the lumbar plexus block. Pre-operative fascia iliaca block provides no benefit compared with general anesthesia alone. Consideration should be given to abandoning fascia iliaca regional nerve block for anesthesia for hip arthroscopy.



Paper 05

Abstract Title:

A Risk Prediction Model for Redislocation Following First Time Lateral Patellar Dislocation (LPD)

Authors:

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Objectives: There is not a formula that is regularly used to help predict the risk of redislocation for an individual patient following first time lateral patellar dislocation (LPD). Our objective was to develop a model to help predict the risk of redislocation that can be easily applied in a clinic visit following first time LPD.

Methods: Between 2008-2012, patients were prospectively identified at 2 musculoskeletal outpatient clinics. Patients were included if they had a history, physical exam, & magnetic resonance imaging (MRI) consistent with LPD without other significant ligamentous injury. Multiple anatomic & injury variables were obtained from the MRI including tibial tubercle - trochlear groove distance, patellar tilt, trochlear depth, trochlear facet asymmetry, trochlear condyle asymmetry, lateral trochlear inclination angle, trochlear sulcus angle (SA), Insall-Salvati ratio (ISR), Caton-Deschamps index, patellotrochlear index, location & severity of chondral injury, location & severity of MPFL injury, location of bone bruising, & whether the patient had open or closed physes (GP). Demographic patient information was also collected to include age, sex, & whether the injury was contact or non-contact. Patients were contacted at a minimum of 2 years post injury to determine if they had experienced a redislocation injury. Demographic and MRI variables were compared between patients with and without patellar redislocation using two group t-tests for continuous variables and Fisher's exact tests for categorical variables; the statistical analysis was completed by an independent professional statistician at our institution. Stepwise logistic regression models were used to identify potential predictors of redislocation. Initially, MRI variables that had continuous data were treated as continuous variables and then a second stepwise logistic regression model was run using binary indicator variables. A cutpoint for each variable was determined using an outcome-oriented approach; the cutpoint yielding the most significant association with the redislocation outcome in a simple logistic regression model was chosen. P-values less than 0.05 were considered statistically significant. A prediction model was then created using the statistically significant variables, and a receiver operating characteristic (ROC) curve was applied to the model to evaluate for diagnostic performance.

Results: Inclusion criteria were met by 108 patients. Of all of the variables, the statistically significant variables were sex, GP, SA, and ISR. The cutpoints were SA \geq 154 degrees and ISR \geq 1.3. The predicted probability of redislocation (percent) was 6.4 for males and 2.3 for females if the patient had closed growth plates and normal SA and ISR. The predicted probability of redislocation (percent) was 89.9 for males and 75.7 for females if the patient had open growth plates and abnormal SA and ISR. If two of three variables (GP, SA, ISR) were positive, the risk was M70.4/F45.4 (GP, SA), M46.5/F23.3 (GP, ISR), and M72.5/F47.9 (SA, ISR). The area under the curve for the ROC curve was 0.81 indicating good diagnostic performance.

Conclusion: Our model demonstrates high risk of redislocation with open growth plates and SA & ISR values above the cutpoints, whereas there are low rates of redislocation with the inverse findings. This model may serve as a clinically applicable means of predicting redislocation following first time LPD.

Paper 06

Abstract Title:

Survival and Reoperation Rate Following Osteochondral Allograft Transplantation: Analysis of Failures for 100 Transplants at 5-year Follow-up

Authors:

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Objectives: The purpose of this study was to quantify survival for osteochondral allograft transplantation (OAT) and report findings at reoperation.

Methods: A retrospective review of a prospectively collected database of patients who underwent OAT by a single surgeon with a minimum follow-up duration of 2-years was conducted. The reoperation rate, timing of reoperation, procedure performed at reoperation, and findings at surgery were reviewed. Failure was defined by revision OAT, conversion to knee arthroplasty, or gross appearance of graft failure at 2nd look arthroscopy. Descriptive statistics, log-rank testing, cross-tabulation, and chi-square testing were performed, with $P < 0.05$ set as significant.

Results: 100 patients (average age 32.7 ± 10.2 years; 53 males, 47 females) who underwent OAT at an average follow-up of 4.9 ± 2.5 years (range, 2.0 to 11.3) were included. Ninety-five patients (95%) underwent an average of 2.7 ± 1.7 prior surgical procedures on the ipsilateral knee prior to OAT. The average defect size was 452.7 ± 181.6 mm² and was located on the medial femoral condyle in 63 patients (63%). Fifty-one percent of OATs were isolated, while 49% were performed with concomitant procedures including meniscus allograft transplantation (MAT) in 27 (27%). Fifty-three patients (53%) returned to the operating room at an average 2.8 ± 2.7 years, with 26% of these patients (14/53) undergoing additional reoperations (range, 1-3 additional reoperations). Arthroscopic debridement was performed in 91% of the initial reoperations (48/53); 55% of reoperations (29/53) were performed within 2 years of the index OAT. Twenty patients (20%) were considered failures at an average 4.0 ± 2.7 years following index OAT either due to revision OAT (N=6), conversion to arthroplasty (N=10), or appearance of poorly incorporated allograft at arthroscopy (N=4). Patients requiring multiple reoperations had an odds ratio of 7.25 (95% CI, 1.85 to 28.37) of OAT failure ($P = 0.004$), while patients requiring secondary surgery within 2 years had an odds ratio of 1.35 (95% CI, 0.48 to 3.82) for OAT failure ($P > 0.05$). Patients with concomitant MAT and OAT were more likely to progress to failure (odds ratio 2.4, 95% CI 0.87 to 3.28). Excluding the failed patients, statistically and clinically significant improvements were found in all outcomes assessments at final follow-up, including Lysholm, IKDC, KOOS, and SF-12 ($P < 0.001$ for all).

Conclusion: In this series, there was a 53% reoperation rate for OAT, with arthroscopic debridement being the most common surgical treatment (91%), and an 80% allograft survival rate at average of 5 years. Those requiring additional surgery still benefited, having a 70% allograft survival rate, but were at

an increased risk of failure, with patients requiring multiple reoperations having an odds ratio of 7.25 for failure. This information can be used to counsel patients on the risks and implications of reoperation following OAT.

Paper 07

Abstract Title:

Functional Outcome of Sesamoid Excision in Athletes

Authors:

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Objectives: Sesamoid issues can have a significantly negative impact on the ability of athletes of all levels to return to play. Conventional treatments include rest, physical therapy (PT), shoe modifications and orthotics. Even with adequate conservative care there are a number of patients who continue to have chronic pain and inability to perform. The literature shows mixed results with sesamoid excisions and ability to return to play. The hypothesis of the study was that with proper surgical technique of sesamoid excisions and adequate rehabilitation, there is a reasonable probability to return to the previous level of sporting activity.

Methods: All athletes presented to the clinic with the diagnosis of sesamoid pain were followed. After approval by the Institutional Review Board, we reviewed only the patients whose symptoms did not resolve. Exclusion criteria included any neurologic deficit or diabetes. Between January 2006 and December 2013, excision of the medial, lateral or both sesamoids was performed for 89 feet in 80 patients (68 females and 12 males). The mean age was 46.25 years old (range 14.1-79.6). All patients had serial x-rays done during the conservative part of their treatment and at least one MRI to confirm the diagnosis of osteochondrosis or chronic injury to the sesamoid. Medial sesamoids were excised through a medial approach, while lateral sesamoids through a plantar approach. Care was taken to adequately repair the plantar structures after excision. A structured post-operative protocol was followed to ensure stability of the plantar plate/sesamoid complex and a gradual return to play over 6 months. A graphite plate was used to limit dorsiflexion for the first 6 months. Outcomes were evaluated pre and postoperatively with the VR-12 Mental and Physical Scores, Revised Foot Function Index (FFI-R), VAS scoring and patient satisfaction.

Results: Eight patients had sesamoid excisions in both feet; fifty-two patients were medial excisions and 18 were lateral sesamoid excisions. Three patients (3 feet) were lost to follow-up; therefore 77 Patients, 86 feet were followed and are reported on. At a mean follow up of 39.72 months [11 months to 9 years (108.4 months) the mean outcome for VR-12 Mental and VR-12 Physical score were insignificant. The FFI-R improved from pre-operative to post-operative, 129.8 to 58.76, respectively. The VAS also improved dropping from 5.06 to 3.05, pre-operatively to post-operatively. One patient had chronic pain and instability and required a fusion. Two patients developed symptomatic hallux valgus deformities that required a surgical repair. There were no cock-up deformities. Of the 77 patients 66 (86%) could return to their previous sporting activity. Two of the 4 bilateral sesamoid excision patients did not return to the previous level of activity. 25% of patients still report some pain, but not enough to limit their activity level.

Conclusion: Chronic sesamoid pain is difficult to treat, but this study confirms prior reports that with

meticulous surgical technique, and a dedicated post-operative rehabilitation program, the likelihood of returning to the previous level of sporting activity is high. The outcomes score also confirm a significant improvement in functional parameters.

Paper 08

Abstract Title:

Effectiveness of a Preseason Prevention Program on Arm Injury Risk Factors: An Randomized Control Trial in Adolescent Pitchers

Authors:

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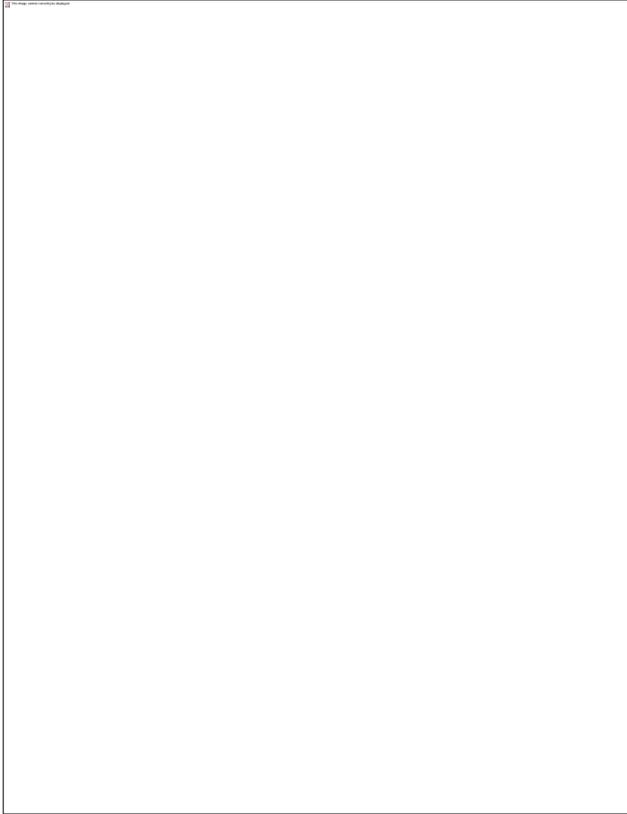
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Objectives: Deficits in posterior shoulder flexibility and strength have been identified as modifiable risk factors for pitching injuries. There are no studies showing the effect of a prevention program on arm injuries and associated risk factors such as strength and ROM. The purpose of this study was to assess the effectiveness of a preseason prevention program to resolve these deficits in adolescent pitchers.

Methods: Baseball pitchers (n=143 age=15.7±1.2; height=165.0±43.8cm; weight=72.2±12.6kg) participating in all team activities were block randomized by school to intervention (INV n=88) or control (CON n=76) groups. The INV group received an Athletic Trainer supervised posterior shoulder flexibility and strengthening program (3x/week for 8-weeks). The CON group participated in their usual training. All pitchers participated in a 4-week interval-throwing program immediate to the start of practice. Bilateral shoulder ROM and strength were assessed pre-post program using a digital inclinometer (DI) to measure supine external rotation(ER), internal rotation (IR), and horizontal adduction (HA) ROM with the scapula stabilized at 90 degrees of abduction. Standard manual muscle testing was used for strength assessments using a hand held dynamometer with arm at the side(ER-0) and in supine 90 degrees/90 degrees (ER-90, IR-90) then normalized to body weight (BW). Injuries were recorded over the subsequent baseball season. Two trials were averaged and used to calculate deficits (non-dominant-dominant) and pre-post change scores to examine the ability of the program to ameliorate baseline deficits associated with injury risk. A one-way ANOVA was used to compare change scores between groups and a 2-way ANOVA (group by injury) to examine the change scores influence on injury ($\alpha=0.05$).

Results: The INV group displayed a greater reduction in IR deficit(INV=7.3 degrees ±11;CON=1.8 degrees ±9;F(1,106)=5.1,P=0.01) P=0.05 and HA deficit(INV=3.3 degrees ±13; CON= -2.4 degrees ±11;F(1,106)=6.7,P=0.01) compared to the CON group. The INV group also maintained their dominant ER-0: IR-90 ratio (INT=-1.6 ±5%BW; CON= -3.5 ±5%BW; F (1,106) =2.1, P=0.09) compared to the CON group. There were 19 arm injuries over the subsequent season (INV=11; CON=8 arm injuries). Control group pitchers who went on to suffer an injury did not decrease their HA deficit (Uninjured=3.0 degrees ±10;Injured=-9.5 degrees ±14;F(1,106)=3.3,P=0.03) or their IR deficit went on to suffer an injury(Uninjured=-1.7 degrees ±8;Injured 8.5 degrees ±13;F(1,106)=3.8,P=0.02). There were no other differences between or among groups (P>0.05).

Conclusion: Adolescent pitchers displayed clinically meaningful improvements in posterior shoulder flexibility (HA and IR) and maintenance of their ER: IR ratio during an Athletic Trainer supervised preseason program. The improvements in HA and IR deficits were associated with decreased injury risk over the course of the subsequent high school season. Thus, a targeted pre-season program appears to be effective in improving HA deficit and impacting injury risk. Further studies are warranted to confirm our results.



Paper 09

Abstract Title:

Does Fatigue Alter Pitching Mechanics?

Authors:

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¹Rush University, Chicago, IL, USA, ²Accelerated Rehab PT, Chicago, IL, USA, ³Rush University Medical Center, Chicago, IL, USA, ⁴Accelerated Physical Therapy, Palos Heights, IL, USA, ⁵Rush University Medical Center Midwest Orthopaedics, Chicago, IL, USA, ⁶Rush Presbyterian St. Luke's Medical Center, Chicago, IL, USA, ⁷Midwest Orthopaedics, Chicago, IL, USA.

Objectives: Background: Injuries of the adolescent shoulder and elbow are common in baseball pitchers. Fatigue has been demonstrated to be a risk factor for injury.

Purpose: To determine if shoulder and elbow kinematics, pitching velocity, accuracy, and pain change during a simulated full baseball game in adolescent pitchers.

Methods: Methods: Adolescent pitchers between the ages of 13-16 were recruited to throw a 90 pitch simulated game. Shoulder range of motion was assessed before and after the game. Velocity and accuracy were measured for every pitch and every 15th pitch was videotaped from two orthogonal views in high definition at 240 Hz. Quantitative and qualitative mechanics were measured from these videos. Perceived fatigue and pain were assessed after each inning using the visual analog scale. Data was statistically analyzed using a repeated-measures analysis of variance.

Results: Results: Twenty-eight elite adolescent pitchers were included. These pitchers, on average, were 14.6±0.9 years old (mean ± standard deviation), had been pitching for 6.3±1.7 years, and threw 94±58 pitches per week. Our experimental model functioned as expected in that pitchers became progressively more fatigued and painful and pitched with a lower velocity as pitch number increased ($p < 0.001$, 0.001, and < 0.001 respectively). Knee flexion at ball release progressively increased with pitch number ($p = 0.008$). Hip and shoulder separation significantly decreased as pitch number increased, from 90%±40% at pitch 15 to 40%±50% at pitch 90 ($p = 0.271$ in all cases, 91% power for elbow flexion at ball release). External rotation and total range of motion in the pitching shoulder significantly increased post-pitching ($p = 0.007$ and 0.047 respectively).

Conclusion: Conclusion: As pitchers progress through a simulated game they throw lower velocity pitches and become fatigued and painful. Core and leg musculature becomes fatigued before upper extremity kinematics change. Based upon these results, the authors hypothesize that core and leg strengthening may be valuable adjuncts to prevent upper extremity injury.

Paper 10

Abstract Title:

Functional Movement Screen and Prior Injury in National Football League Combine Athletes

Authors:

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Objectives: Functional Movement Screen (FMS) testing is frequently used to assess deficits in range of motion, balance, and stability. The purpose of this study was to determine whether the results of the FMS performed at the National Football League (NFL) Combine were associated with a history of previous injury in the elite collegiate athlete.

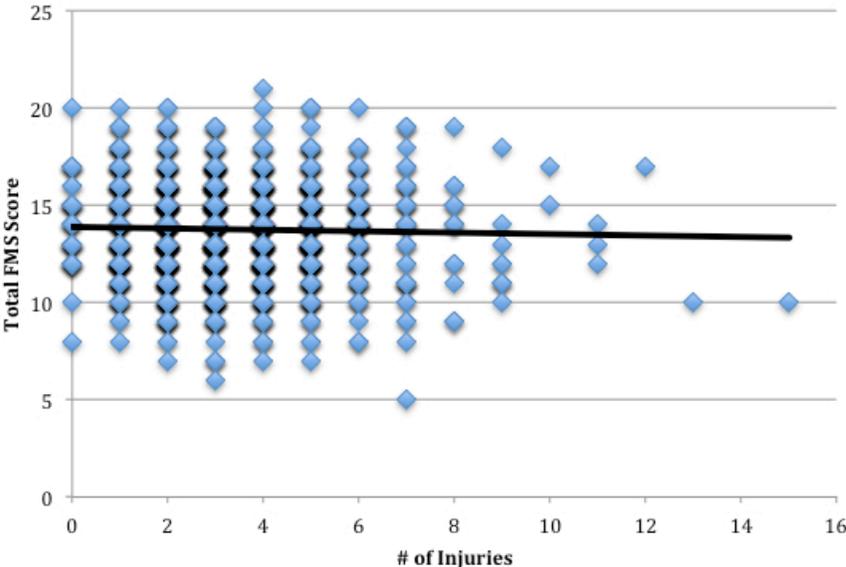
Methods: Records from 1263 athletes participating in FMS testing at the NFL Combine over a five-year period were reviewed. Player position, injury history (including total number of injuries), the need for surgery, and number of games missed due to injury was recorded. Comparisons between FMS score, the number of asymmetries during FMS testing, position and injury history were performed. A one-way analysis of variance was performed with Tukey post-hoc comparisons to compare FMS score and position. Chi-square was used for all categorical and dichotomous variable comparisons. Spearman correlation was also used to assess the relationship between FMS, number of asymmetries, number of games missed and number of injuries recorded. The a priori alpha level was established at $p \leq .05$

Results: Overall 1228 (97.2%) of participants reported one or more injuries. Average FMS score was 13.8 ± 2.4 . Offensive and defensive lineman were more likely to score lower on the FMS ($p < .001$). No significant difference was seen between total FMS score and number of injuries ($p = .806$) or number of games missed due to injury ($p = .714$). A significant difference was noted between the number of asymmetries during FMS testing and number of games missed ($p = .002$), however when games missed was stratified between zero missed games and one or more games, no significant differences were noted. ($p = .628$). There was also no correlation between FMS asymmetries and number of injuries ($p = .362$).

Conclusion: The results of this study suggest that within elite athletes at the NFL Combine, no correlation exists between prior injury history and FMS score. A comparison between FMS asymmetry and the number of games missed was significant when games missed was not stratified, however when games missed was stratified the statistical significance was eliminated. There was no difference between asymmetries and total number of injuries. Caution should be exercised when attempting to evaluate an athlete's FMS performance with specific movement patterns perceived to be reflective of past injury. Ultimately, further research is required to clearly outline the utility and efficacy of the FMS in the elite

American football population.

FMS vs. Injury History



Paper 11

Abstract Title:

Radiostereometric Evaluation of Tendon Elongation after Distal Biceps Repair

Authors:

Nathan Marshall¹, Robert A. Keller, MD², John-Michael Guest³, Vasilios Moutzouros, MD⁴.

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Objectives: Operative repair of distal biceps tendon ruptures have shown successful outcomes. However, little is known about the amount of tendon or repair site lengthening or creep. Treatment algorithms in regards to repair fixation, immobilization, initiation of activity and physical therapy are largely made on previous tendon healing principles and anecdotal findings. The purpose of our study was to evaluate distal biceps tendon repair via intratendinous radiostereometric analysis to evaluate tendon lengthening/creep at different time intervals of healing.

Methods: Ten patients were recruited who sustained a distal biceps rupture requiring operative repair. Distal biceps repairs were performed using an endobutton only, single incision technique. Intraoperatively, two 2-mm tantalum beads with laser-etched holes were sutured to the distal biceps tendon. One bead was placed at the radius tendon interface and the other placed 1cm proximal to the first bead. Beads were evaluated via both CT scans immediately post-operatively and at 16 weeks and x-rays obtained at time 0 and then at 4, 8, and 16 weeks. Measurements were made using the endobutton to bead and bead-to-bead distances in order to assess repair site elongation as well as tendon elongation over time. Following final follow-up, patients underwent a DASH questionnaire and ultrasound to confirm the integrity of the tendon.

Results: Ten patients were included in the study. Nine patients had complete ruptures with one having a partial rupture that underwent completion and subsequent repair. All patients showed statistically significant lengthening after surgery. The mean amount of lengthening after surgery was 21.8 mm (range 10.1-29.7 mm, $p < 0.05$). The repair site lengthened a mean of 12.5 mm (range 8.8-17.0 mm, $p < 0.05$) and the tendon lengthened a mean of 9.4 mm (range: 4.0-18.8 mm, $p < 0.05$) from surgery to final follow-up. The greatest change in lengthening was noted between time 0 and week 4 (mean: 11.8 mm, range: 4.0-18.0 mm, $p < 0.05$), with the least amount of lengthening between week 8 and week 16 (mean: 3.6 mm, range: 2.1-5.5 mm, $p < 0.05$). Average DASH scores after surgery was 4.5 (range: 2.5-16.7). Final ultrasound evaluations found no re-ruptures in any of the patients.

Conclusion: This study's findings suggest that all patients undergoing distal biceps tendon repair have significant elongation of their repair site and tendon after surgery, with the greatest amount of lengthening seen in the early post-operative period. These findings lend insight into decision-making with regards to intraoperative repair fixation and post-operative activity protocols while also adding knowledge to overall tendon repair principles.

Paper 12

Abstract Title:

Lacertus Fibrosis versus Achilles Allograft reconstruction for Chronic Distal Biceps Tears: A Biomechanical Study

Authors:

Miguel Ramirez, MD¹, Anand Murthi, MD².

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Objectives: Chronic distal biceps tears can be difficult to treat as in many cases, the remaining biceps tendon is significantly retracted and an allograft may be required to provide length for reconstruction. The lacertus fibrosis (LF), being a local, stout, fibrous sheath, can potentially be used as a reconstruction graft, obviating the need for allograft tissue. The purpose of this study is to evaluate the strength of the lacertus fibrosis compared to achilles allograft (AA) for distal biceps reconstruction.

Methods: 10 fresh-frozen matched cadaveric pairs of elbows were used in this study. The distal biceps tendon was isolated and 3 centimeters of tendon was resected. In Group 1, the LF was identified and released from its distal attachment, maintaining its attachment to the biceps muscle. This was then tubularized and repaired to the radius via button fixation. In Group 2, an AA tendon graft was sutured to the biceps muscle via Pulvertaft weave and similarly repaired to the ulna via button fixation. The prepared radii were rigidly mounted at a 45-degree angle in a MTS electromechanical test frame (MTS Systems, Eden Prairie, MN). The proximal biceps muscle was secured in a custom fabricated cryogenic grip and allowed to freeze for 60s prior to testing. Two differential variable reluctance transducers (DVRTs) were mounted on the specimens, one at the radius-soft tissue junction and the second in the muscle or muscle allograft tissue junction proximal to the repair. Specimens were then loaded at a displacement rate of 20 mm/min until failure. Failure was defined as a 3 mm displacement of the DVRT located at the radius-soft tissue junction. Stiffness was calculated from the initial linear portion of the load versus radial DVRT curve. A t-test was used to determine if any observed differences were significant ($p \leq 0.05$)

Results: Load to failure, as defined as a 3mm gap formation by DVRT was similar between both groups. Load to failure in Group 1 (LF) was 20.17 ± 5.52 N versus 16.89 ± 4.54 N in Group 2 (AA) ($p=0.18$). Stiffness of the construct was also not statistically different, with Group 1 (LF) averaging 12.32 ± 7.11 KPa versus 10.48 ± 5.66 KPa in Group 2 (AA) ($p=0.34$).

Conclusion: Lacertus fibrosis reconstruction for chronic distal biceps tears was as strong biomechanically as the commonly used achilles tendon allograft in terms of load to failure and construct stiffness. This may be a reasonable alternative for chronic distal biceps reconstruction in which primary repair is not possible.

Paper 13

Abstract Title:

Ulnar Collateral Ligament Repair with Internal Brace Augmentation: A Novel UCL Repair Technique in the Young Adolescent Athlete

Authors:

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Objectives: Objective: Our purpose is to describe a novel surgical technique for Ulnar Collateral Ligament repair in the young adolescent, and present the clinical results of a retrospective cohort of patients. We hypothesized that using an internal brace to augment the repair of the native ulnar collateral ligament would allow for a more aggressive physical therapy protocol and ultimately facilitate both an expeditious return to sport and a high level of patient satisfaction.

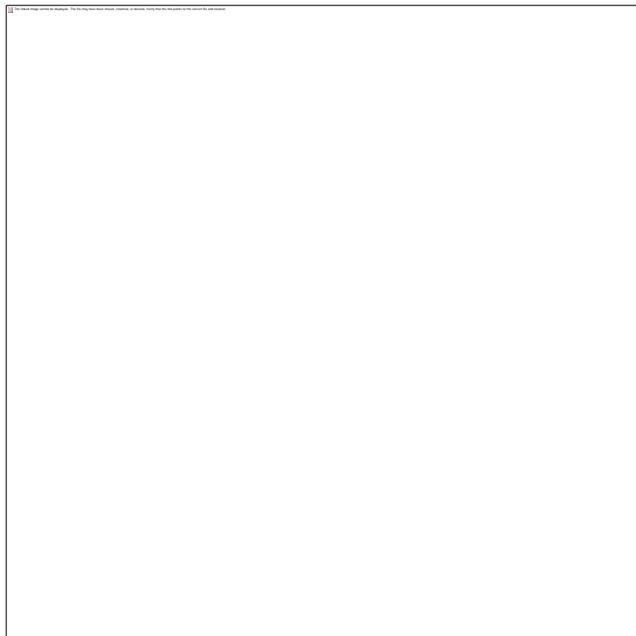
Methods: Methods: After obtaining IRB approval for this study, our institutional electronic database was utilized to identify all patients who had undergone our novel technique for UCL repair between the years 2013-2014. An orthopedic fellow conducted phone surveys and the KJOC questionnaire was administered. Primary outcome measures included KJOC scores at 6 and 12 months, time to initiation of a plyometrics regimen, an interval throwing program and return to sports. Secondary measures including patient satisfaction, level of competition achieved and percent return to normal were also collected.

Results: Results: Twenty-two patients (19 male/3 female, average age 17.8 years) underwent surgery between 2013-2014. All patients were high school level athletes at the time of injury and included nineteen baseball players (13 pitchers), two football players, a javelin thrower and a cheerleader. Injury patterns included seven proximal tears, one mid substance, thirteen distal and four avulsions. Nine patients underwent ulnar transposition at the time of surgery, one had undergone prior transposition and the remainder of the patient's ulnar nerves were left in situ.

At six and twelve months the average KJOC scores respectively were 88.3 and 93. Patients that underwent transposition had KJOC scores of 78.3 at six months and 97.5 at twelve while patients that were left in-situ scored 82 and 91. These differences were not significant. The average number of weeks until initiation of plyometrics was seven and an interval throwing program was initiated on average, by week eleven. The average time to throwing from the mound was twenty weeks and full return to sports was twenty-one. Twelve of the thirteen pitchers made it back to the same or next level and six of them did so by transitioning from another position back to pitcher. The remaining athletes in the cohort all returned to competition at their pre injury level. At six months all but one patient was "very" satisfied and at twelve months, all were satisfied. At six months, patients deemed themselves to be at 92% normal and at twelve months, 96%.

Conclusion: Conclusion: Recently, there have been an increasing number of throwing athletes with injuries to the ulnar collateral ligament (UCL) and a seemingly exponential rise amongst adolescents. The argument for repair rather than reconstruction in younger athletes is supported by both the observation that ligaments in these patients are absent the chronic attritional damage and secondary pathologic joint changes so frequently observed in injuries amongst higher-level athletes and the results of several recent clinical studies where a reliable and rapid return to overhead sports in this patient subset has been achieved. The current study demonstrates that our novel technique of UCL repair with internal brace augmentation shows early promise for accelerated therapy and ultimately faster return to play in adolescent athletes.

Patient Outcomes								
	General	Trans	InSitu	Pitcher	Baseball	Cheer	Javelin	Football
KJOC 6mos	88.3	78.3	82.1	89.3	82.8	94	92	94
KJOC 12mos	93.1	97.5	90.9	97	93.7	100	98	93
PLYO (weeks)	7	7.2	6.8	6.7	7	6	6	8
ITP (weeks)	11.6	12.9	10.8	10.9	13.4		10	15
RTM (weeks)		20.5	18.8	20.3				
RTS (weeks)	21.3	22	20.7	22.5	21.5	20	14	16
%Normal @ 12mos	.96	.98	.95	.98	.94	1	.9	.95



Paper 14

Abstract Title:

Ulnar Collateral Ligament Reconstruction; the Rush Experience

Authors:

Brandon J. Erickson¹, Bernard R. Bach, MD², Mark S. Cohen, MD³, Charles A. Bush-Joseph, MD⁴, Brian J. Cole, MD, MBA⁵, Nikhil N. Verma, MD⁶, Gregory P. Nicholson, MD⁷, Anthony A. Romeo, MD³.

¹Rush University, Chicago, IL, USA, ²Midwest Orthopaedics at RUSH, Chicago, IL, USA, ³Midwest Orthopaedics, Chicago, IL, USA, ⁴Rush University Medical Center Midwest Orthopaedics, Chicago, IL, USA, ⁵Midwest Orthopaedics at Rush, Chicago, IL, USA, ⁶Rush Presbyterian St. Luke's Medical Center, Chicago, IL, USA, ⁷Rush Presbyterian St Lukes Med CtrMidwest Ortho, Chicago, IL, USA.

Objectives: Background: Ulnar collateral ligament reconstruction (UCLR) is now a common surgery performed in both professional, as well as high level athletes

Purpose: To report the patient demographics, surgical techniques, and outcomes of all UCLR performed at a single institution from 2004-2014

Hypothesis: UCLR will be performed mostly in male pitchers and will have a complication rate of less than 5%

Methods: Methods: The surgical database of one institution was searched from January 1st 2004-December 31st 2014 for the current procedural terminology (CPT) code 24346 "Reconstruction medial collateral ligament, elbow, with tendon graft (includes harvesting of graft)". Charts were reviewed to determine patient age, gender, date of surgery, sport played, athletic level, surgical technique, graft type, and complications were recorded. Patients were contacted via phone calls to obtain the return to sport rate, Conway-Jobe score, Timmerman & Andrews score, and Kerlan-Jobe Orthopaedic Clinic (KJOC) Shoulder and Elbow score.

Results: Results: One hundred eighty-nine patients underwent UCLR during the study period (92% male, average age 19.6 +/- 4.9 years, 77.8% were right elbows). There were 166 baseball players (87.8% of all patients), 156 of which were pitchers (82.5% of all patients). Ninety-eight (51.6%) were college athletes, 62 (36%) were high school athletes, and 25 (13.2%) were professional athletes at the time of surgery. The docking technique was used in 111 (58.7%) patients while the double docking technique was used in 78 (41.3%). An ipsilateral palmaris longus graft was used in 111 (58.7%) of patients while a hamstring autograft was used in 48 (25.4%) patients. The ulnar nerve was subcutaneously transposed in 79 (41.8%) patients. Overall 95.7% of patients were able to return to sport and had a Conway-Jobe score of good/excellent while 4.3% had a score of fair. The average KJOC score was 94.7 +/- 5.7 and average Timmerman-Andrews score was 93.7 +/- 7.7. Subsequent surgeries were performed in 5.8% of patients.

Conclusion: Conclusion: Overall 95.7% of patients who underwent UCLR were able to return to sport with an average KJOC score of 94.7 and Timmerman Andrews Score of 93.7.

Paper 15

Abstract Title:

Unintended Consequences of Concussion Prevention in NCAA Football

Authors:

Robert W. Westermann, MD¹, Peter Wehr, MD¹, Annunziato Amendola, MD².

¹University of Iowa, Iowa City, IA, USA, ²UI Sports Medicine, Iowa City, IA, USA.

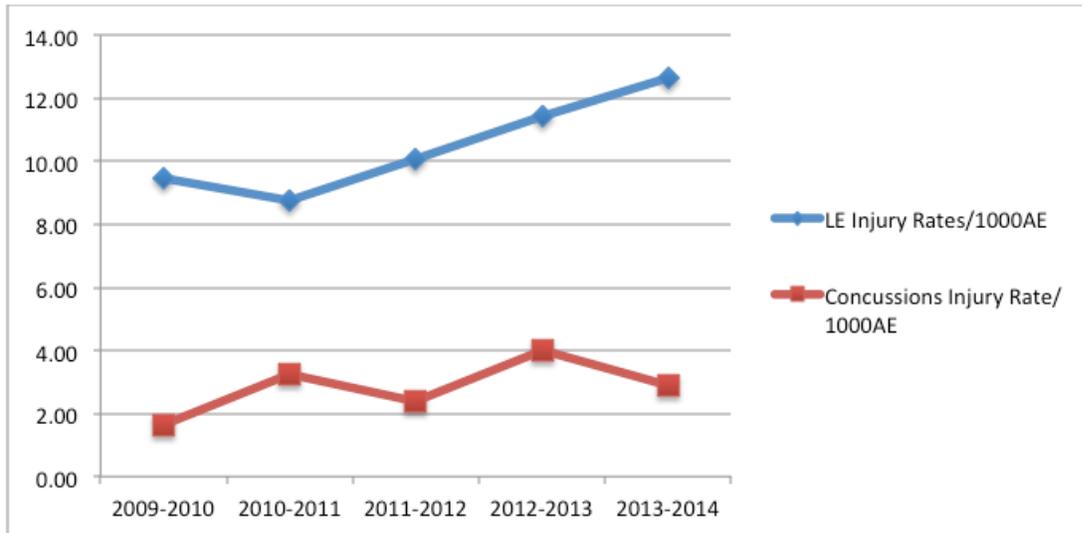
Objectives: Both lower extremity and head injuries are common in American Football players. Concussions, or Mild Traumatic Brain Injuries (MTBIs), have gained increased interest in the past decade. Recurrent MTBIs have been associated with late-life cognitive impairment and depression in American Football populations.^{2, 3} beginning in 2008, the NCAA introduced rule changes with the intent to halt or reverse the increasing rates of MTBIs in its players. Lower-extremity injuries in American football populations have been associated with increased rates of post-traumatic osteoarthritis¹ and significantly contribute to disability in retirement. While lower extremity injury rates have been studied and associated with weather⁵ and playing surface⁴, no such study has sought an association between lower extremity injury with the timing/introduction of rule changes used to prevent head injuries. The purpose of this study was to assess if lower extremity injury rates are increasing after concussion rule changes. We hypothesize that there may be a compensatory increase in lower extremity injury rates as players act to avoid head-to-head contact and comply with instated rules.

Methods: The NCAA Injury Surveillance System (NCAA ISS) database was queried for in-game injuries suffered between 2009-2014. All injuries suffered by NCAA Football players that occurred in competition were identified. Injuries that did not result in lost participation time were excluded. Lower extremity injuries that resulted in lost time included injuries to the thigh/upper leg, knee, lower leg/Achilles, ankle and foot. All concussions resulting in lost time were also identified during the same time period for comparison. Data regarding athletic exposures was collected in order to calculate the incidence of injury.

Results: Between 2009 and 2014, 48 NCAA Football programs provided data on 123 team-seasons to the NCAA ISS for analysis. The incidence of lower extremity injuries increased from 9.45 injuries per 1000AE in the 2009-2010 season to 12.63 injuries per 1000AE in the 2013-2014 season. The rate of concussions suffered by American Football players, during the same time period, did not significantly change (1.64 concussions per 1000AE's in 2009-2010 season versus 2.87 concussions per 1000 AE's in the 2013-2014 season) [Graph 1].

Conclusion: Given heightened societal interest in concussions, the NCAA has implemented several rule changes in order to influence how American Football is played. Since the initiation of these rule changes, concussion rates have remained stable. During our study period, injuries to the lower extremity have increased. In order to comply with avoiding head-to-head contact, players may be targeting the lower extremities. This is concerning as lower extremity injuries and post-traumatic osteoarthritis are common causes of disability in retired American Football players.

Graph 1: The incidence of lower extremity (LE) injuries versus the incidence of concussions in NCAA American Football between 2009-2014.



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Paper 16

Abstract Title:

CNS Voltage-gated Calcium Channel Gene Variation And Prolonged Recovery Following Sport-related Concussion

Author:

Jane McDevitt, PhD.

Temple University, Douglassville, PA, USA.

Objectives:

To examine the association between concussion duration and two calcium channel, voltage-dependent, R type, alpha 1E subunit (CACNA1E) single nucleotide polymorphisms (i.e., rs35737760 and rs704326). A secondary purpose was to examine the association between CACNA1E single nucleotide polymorphisms (SNPs) and three acute concussion severity scores (i.e., vestibule-ocular reflex test, balance error scoring scale, and Immediate Post-Concussion Assessment and Cognitive Testing).

Methods: Forty athletes with a diagnosed concussion from a hospital concussion program completed a standardized initial evaluation. Concussion injury characteristics, acute signs and symptoms followed by an objective screening (i.e., vestibular ocular assessments, balance error scoring system test, and Immediate Post-Concussion Assessment and Cognitive Testing exam) were assessed. Enrolled participants provided salivary samples for isolation of DNA. Two exon SNPs rs35737760 and rs704326 within CACNA1E were genotyped.

Results: There was a significant difference found between acute balance deficits and prolonged recovery group ($X^2 = 5.66$, $p = 0.017$). There was an association found between the dominant model GG genotype ($X^2 = 5.41$, $p = 0.027$) within the rs704326 SNP and prolonged recovery group. Significant differences were identified for the rs704326 SNP within the dominant model GG genotype ($p = 0.030$) for VOR scores by recovery. A significant difference was found between the rs704326 SNP codominant model AA ($p = 0.042$) and visual memory. There was an association between acute balance deficits and prolonged recovery ($X^2 = 5.66$, $p = 0.017$) for the rs35737760 SNP. No significant associations between concussion severity and genotype for rs35737760 SNP.

Conclusion: Athletes carrying the CACNA1E rs704326 homozygous genotype GG are at a greater risk of a prolonged recovery. Athletes that reported balance deficits at the time of injury were more likely to have prolonged recovery. These polymorphisms within CACNA1E could alter the CACNA1E protein and allow for an increase of calcium leading to deficits to the granule cells within the brain.

Paper 17

Abstract Title:

Characterizing Radiographic Hip Anatomy and Relationship to Hip Range of Motion and Symptoms in National Hockey League (NHL) Players

Authors:

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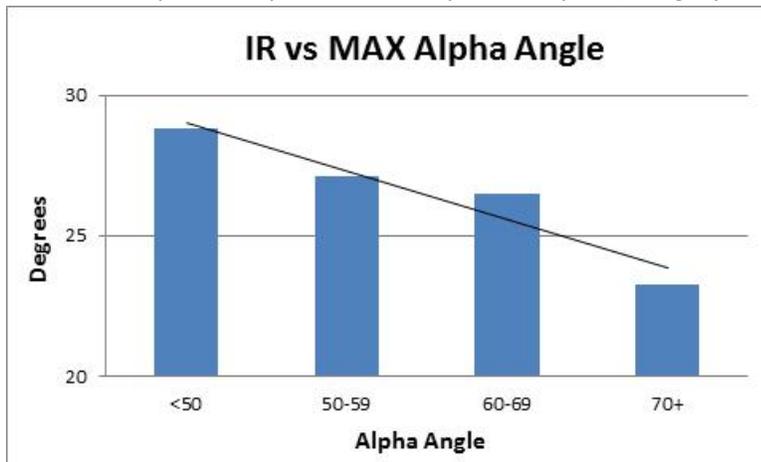
Objectives: The objective of this study was to characterize the radiographic proximal femoral and acetabular anatomy for professional (NHL) hockey players, and to correlate with objective assessments of hip range-of-motion and current or prior hip symptoms / surgery.

Methods: One hundred and eighteen hips in 59 professional hockey players with one NHL organization (mean age 24.2, range 18-36) underwent a history and physician examination by two independent orthopedic surgeons for direct flexion, adduction, abduction in extension and flexion, and internal and external rotation at 90 degrees of flexion. A history of current or previous groin / hip pain or prior hip and/or core muscle surgery was noted. Well-positioned anteroposterior (AP) pelvis and bilateral Dunn lateral radiographs were obtained for all players with measurements performed independently by two-fellowship trained, hip preservation surgeons to assess acetabular and proximal femoral morphology. Statistical analysis was performed with linear regression models, Pearson and Spearman correlations, as well as intra-class correlation coefficients to assess inter-rater reliability, with $p < 0.05$ defined as significant.

Results: Good to Very Good reliability of radiographic assessments were revealed (ICC = .749 - .958, $p < .01$). With regards to acetabular retroversion, 64% of the athletes had a positive-crossover sign (COS), while 86% and 60% had a positive posterior wall (PWS) and prominent ischial spine sign (ISS), respectively. Mean lateral center edge angle (LCEA) was $28.3^\circ \pm 4.6^\circ$, and mean Tonnis angle $7.0^\circ \pm 4.1^\circ$. 18% of hips demonstrated borderline dysplasia (LCEA 20° - 25°) and 3% frank dysplasia (LCEA $< 20^\circ$). Femoral head asphericity as assessed by AP and lateral alpha angles was $52.2^\circ \pm 11.2^\circ$ and $61.0^\circ \pm 10.1^\circ$, respectively. Both the mean AP and lateral head-neck offset ratio was 0.14 ± 0.02 . 85% and 89% of hips demonstrated cam-type proximal femoral morphology based on increased alpha angle and reduced head-neck offset respectively. Very good reliability was confirmed for all ROM assessment (ICC > 0.80) with the exception of direct adduction, which demonstrated good reliability (ICC = 0.69). Mean hip flexion was 107.4 ± 6.7 , abduction and adduction 37.6 ± 8.7 and 20.5 ± 5.2 respectively, and IR and ER in 90 degrees of flexion 26.1 ± 6.6 and 44.2 ± 8.6 respectively. 31.4% percent of hips had current or prior history of hip related pain / surgery. Higher AP, lateral, and maximal alpha angles all correlated with decreased hip internal rotation ($p = 0.004$). Greater AP alpha angle correlated with decreased hip extension /abduction ($p = 0.025$), and

greater lateral and maximal alpha angle correlated with decreased hip flexion / abduction ($p=0.001$). Acetabular parameters (LCE, COS, ISS, Tonnis angle) did not correlate with hip ROM. Decreased hip ER correlated with an increased risk for current or prior hip related pain / surgery ($p < 0.001$).

Conclusion: Hip anatomy in NHL hockey players is characterized by highly prevalent cam-type morphology (>85%) and acetabular retroversion (> 60%). In addition, dysplasia (21%) was relatively common. Greater cam type morphology (higher alpha angle) correlated with decreased hip IR, Ext / ABD, and Flex / ABD ROM, whereas acetabular parameters did not correlate with hip ROM. Only decreased hip ER was predictive of hip related pain / surgery.



Paper 18

Abstract Title:

Arthroscopic Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears: A Prospective Clinical Study in 100 Consecutive Patients with 1 To 8 Years of Follow-up

Authors:

Teruhisa Mihata, MD, PhD¹, Thay Q. Lee, PhD², Yasuo Itami, MD³, Akihiko HASEGAWA, MD, PhD⁴, Mutsumi Ohue, MD⁵, Masashi Neo, MD, PhD¹.

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Objectives: An arthroscopic superior capsule reconstruction, in which the fascia lata autograft attached medially to the superior glenoid and laterally to the greater tuberosity, restores shoulder stability and muscle balance in patients with irreparable rotator cuff tears; consequently, it improves shoulder function specifically deltoid muscle function and relieves pain. We assessed the clinical outcome of arthroscopic superior capsule reconstruction (Figure 1) in 100 consecutive patients with irreparable rotator cuff tears. Specifically, we focused on the rates of return to sport and work.

Methods: From 2007 to 2014, we performed arthroscopic superior capsule reconstruction on 107 consecutive patients (mean 66.7 years; range, 43 to 82) with irreparable rotator cuff tears that had failed conservative treatment. Seven patients were lost to follow-up because of other medical problems or reasons. In the remaining 100 patients there were 56 supraspinatus and infraspinatus tears; 39 supraspinatus, infraspinatus, and subscapularis tears; 3 supraspinatus, infraspinatus, teres minor, and subscapularis tears; and 2 supraspinatus, infraspinatus, and teres minor tears. Physical examination, radiography, and MRI were performed before surgery; at 3, 6, and 12 months after surgery; and yearly thereafter. Rates of return to sport and work were also investigated in those patients who had been employed (34 patients: 21 manual workers, 10 farmers, 1 butcher, 1 cook, and 1 athletic trainer) or played sport (26 patients: 6 golf, 4 table tennis, 4 swimming, 3 martial arts, 2 baseball, 2 yoga, 1 tennis, 1 badminton, 1 skiing, 1 mountain-climbing, and 1 ground golf) before injury.

Results: The average preoperative American Shoulder and Elbow Surgeons (ASES) score was 31.6 points (range, 3.3 to 63.3 points) and the average Japanese Orthopaedic Association (JOA) score was 51.6 points (26.5 to 68.5 points). Average postoperative clinical outcome scores all improved significantly at final follow-up (mean, 36.6 months after surgery; range, 12 to 96 months; ASES, 93.3 points; JOA, 92.2 points) ($P < .00001$). Ninety-two patients (92%) had neither graft tear nor re-tear of the repaired rotator cuff tendon during the follow-up period (5 to 8 years of follow-up, 17 patients; 3 to 4 years of follow-up, 19 patients; 1 to 2 years of follow-up, 56 patients). Postoperative clinical outcome scores and active elevation at final follow-up were significantly better in healed patients (ASES, 95.5 points; JOA, 93.7 points, $154.8^\circ \pm 24.2^\circ$) than in unhealed patients suffering from graft tear or re-tear of the repaired rotator cuff tendon (ASES, 76.3 points, $P < 0.0001$; JOA, 79.5, $P < 0.001$; $115.0^\circ \pm 41.8^\circ$, $P < 0.001$).

Thirty-two patients returned fully to their previous jobs, whereas two patients returned with reduced hours and workloads. All 26 patients who had played sport before their injuries returned fully to their previous sports, although most of the patients had been playing at recreational level before their injuries.

Conclusion: Arthroscopic superior capsule reconstruction restored shoulder function and resulted in high rates of return to recreational sport and work. Graft tear or re-tear of the repaired rotator cuff tendon exacerbated the clinical outcome after superior capsule reconstruction. These results suggest that arthroscopic superior capsule reconstruction is a viable surgical option for irreparable rotator cuff



tears, especially in patients who work and enjoy sport.

Paper 19

Abstract Title:

Interposition Porcine Acellular Dermal Matrix Xenograft Successful Alternative in Treatment for Massive Rotator Cuff

Authors:

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Objectives: Despite advances in the surgical techniques of rotator cuff repair (RCR), the management of massive rotator cuff tears in shoulders without glenohumeral arthritis poses a difficult problem for surgeons. Failure of massive rotator cuff repairs range from 20-90% at one to two years postoperatively using arthrography, ultrasound, or magnetic resonance imaging. Additionally, there are inconsistent outcomes reported with debridement alone of massive rotator cuff tears as well as limitations seen with other current methods of operative intervention including arthroplasty and tendon transfers. The purpose of this prospective, comparative study was to determine if the repair of massive rotator cuff tears using an interposition porcine acellular dermal matrix xenograft improves subjective function, pain, range of motion, and strength at greater than two years follow-up. To our knowledge, this is the largest prospective series reporting outcomes of using porcine acellular dermal matrix xenograft as an interposition graft.

Methods: Thirty-seven patients (37 shoulders) with an average age of 66 years (range 51-80 years) were prospectively followed for 33 months (range 23-48) following massive RCR using porcine acellular dermal matrix interposition xenograft. Subjective outcomes were measured using the Visual Analog Scale (VAS) pain score (0-10, 0 = no pain), Modified American Shoulder and Elbow Score (M-ASES), and Short-Form12 (SF-12) scores. Preoperative and postoperative objective outcome measures included active range of motion and supraspinatus and infraspinatus manual muscle strength. Postoperative outcome measures included quantitative muscle strength using a dynamometer and static and dynamic ultrasonography to assess the integrity of the repair.

Results: Average VAS pain score decreased from 4.5 to 1.1 ($P<0.001$). Average postoperative M-ASES was 89.23. Average postoperative SF-12 was 52.6. Mean forward flexion, external and internal rotation significantly improved from 133.2° to 157.9° ($P=0.003$), 51.56° to 64.25° ($P=0.001$), and 49.8° to 74.0° ($P<0.001$), respectively. Manual strength (10 point scale) in supraspinatus and infraspinatus increased from 7.3 to 8.9 ($P<0.001$) and 7.4 to 9.4 ($P<0.001$), respectively. Using a dynamometer, supraspinatus quantitative strength was a mean of 68.6N and infraspinatus quantitative strength was a mean of 50.6N. Ultrasound evaluation of repairs showed 33 (89.1%) to be fully intact, three (8.1%) had partial tears, and one repair (2.7%) was not intact. The one patient whose repair was not intact by ultrasound was a revision repair. No infections, evidence of inflammatory reaction, tissue rejection, or major adverse outcomes were identified. Three patients underwent ipsilateral shoulder surgery for lysis of adhesions

due to post-operative decreased ROM during the follow-up period.

Conclusion: Following repair of massive rotator cuff tears with interposition porcine acellular dermal matrix xenografts, patients had significant improvement in pain, range of motion, strength and reported good subjective function based on M-ASES and SF-12 scores. The repair was completely intact in 89% of patients, a vast improvement compared with results reported for primary repairs of massive rotator cuff tears. Tissue grafts such as the porcine acellular graft used in our study hold great promise in the treatment of massive, retracted rotator cuff tears.

Paper 20

Abstract Title:

Tape versus Suture - A Biomechanical and Clinical Analysis in Arthroscopic Rotator Cuff Repair of Large Tears

Authors:

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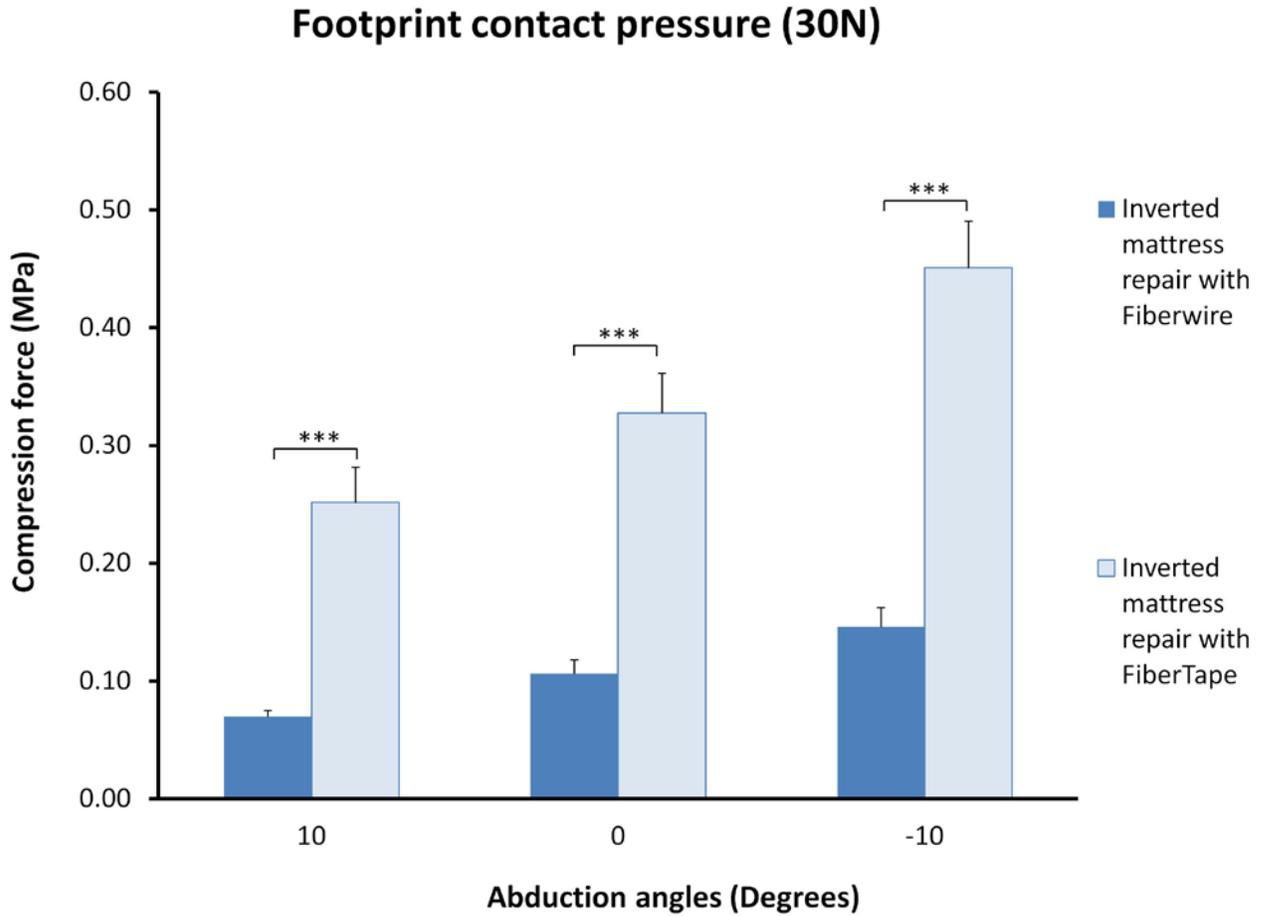
Objectives: Clinical studies have shown that repairs of larger rotator cuff tears are less likely to re-tear than repairs of smaller and partial thickness tears. Clinical studies have also shown that rotator cuff repair with an arthroscopic tension band technique have a lower re-tear rate at six months and two years post-surgery compared to simple suture-anchor technique, probably due to higher compression at the tendon-bone interface (footprint). Advances in suture anchor systems have allowed a wider tape to be used for rotator cuff repairs. Therefore the aims of this study were 1) to determine if there is any biomechanical and/or clinical benefits of using fibertape versus #2 suture in arthroscopic repair of large full thickness rotator cuff tears.

Methods: Rotator cuff tears of the infraspinatus tendon were created in 16 ovine shoulders. The tendons were re-attached to the footprint using a tension band repair technique with two different types of sutures: 1) #2 suture (Fiberwire, Arthrex) or 2) tape (FiberTape, Arthrex) with an inverted mattress single row configuration using the same knotless anchor (Swivel-lock, Arthrex) system. Following repair, footprint contact pressure was measured with 10, 20, 30 N applied to the repaired tendon and at -10deg, 0deg, 10deg of abduction. Repair strength was determined by a pull-to-failure test. A retrospective analysis of prospectively assessed consecutive patients who underwent arthroscopic rotator cuff repair with full thickness tears larger than 1.5cm x 1cm by a single surgeon. There were 50 patients in the tape repair group and 100 patients in the suture repair group. Patients ranked pain and functional scores, shoulder strength and range of motion were recorded pre and post-operatively at one, six, 12 and six months. Ultrasound was used to evaluate the repair integrity at six months post-surgery.

Results: Rotator cuff repair using tape had higher footprint contact pressure ($0.33\text{MPa} \pm 0.03\text{MPa}$ vs $0.11\text{MPa} \pm 0.3\text{MPa}$, $p < 0.0001$, mean \pm SEM) compared to repair with #2 sutures at 0° abduction with a 30 N load applied across the repaired tendon. Ultimate failure load of tape repair was higher than suture repair (217 ± 28 N vs 144 ± 14 N, $p < 0.05$). Clinical data showed both group reported significantly lower frequency and magnitude of pain during overhead activity and sleep at six months compared to pre-surgery levels ($p < 0.001$). At six months post-surgery the suture repair group had better internal rotation (+3 vertebral levels) and external rotation (+18deg) compared to the tape repair group ($p < 0.001$). Both groups had similar shoulder strength at six months. The re-tear rate was similar between the tape group (16%) (8/ 50) and the suture group (17%) (17/100).

Conclusion: The biomechanical study showed that rotator cuff tears repaired with inverted mattress knotless single row constructs with tape increased the tendon-bone footprint compression three fold

and the construct strength 1.5 fold compared to repairs performed with suture. The biomechanical advantages of tape did not, however, translate to clinical benefits with both constructs resulting in relatively good healing rates in patients with large cuff tears. Patients repaired with tape, however, were stiffer in internal and external shoulder rotation at six months.



Paper 21

Abstract Title:

Are We Getting Any Better? A Study on Repair Integrity in 1600 Consecutive Arthroscopic Rotator Cuff Repairs

Authors:

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Objectives: Post-operative re-tear is the most common surgical complication following rotator cuff repair with reported rates ranging from 11% to 94%. There have been a number of advancements in the technology and management of rotator cuff repair which may have improved re-tear rates.

The aim of this study was to determine if there has been any improvements in rotator cuff repair integrity in our centre and, to identify any changes in the management of rotator cuff tears that may have impacted post-operative re-tear rate.

Methods: This observational single cohort study used running average analysis to examine 1600 consecutive patients who underwent primary arthroscopic rotator cuff repair by a single surgeon, and had cuff integrity assessed by ultrasound six months post operation. Exclusion criteria included revision rotator cuff repairs, isolated subscapularis repairs, and irreparable tears.

Results: Re-tear rates over the course of our study ranged from 3% to 34%, with the mean re-tear rate being 15%. The re-tear rate at the commencement of our study was 18% and decreased to 5% by the end. Reductions in re-tear were associated with; more passive rehabilitation, more attention to post-operative abduction sling use, increased surgical team experience. Increases in re-tear rates were associated with; increased false positives with a more sensitive ultrasound machine and, learning curves with new equipment for surgeon and sonographer.

Conclusion: A significant decrease in re-tear rate following arthroscopic rotator cuff repair was observed over the course of our study with the re-tear rate at the end of the study being 5%. While the study design does not allow us to directly attribute changes in re-tear rate to changes in management, our results suggest that less aggressive rehabilitation, abduction sling use and increased surgeon experience decrease postoperative re-tear.

