

# Sports Medicine Research Day

*Friday, June 14, 2019*

**Stedman Auditorium**

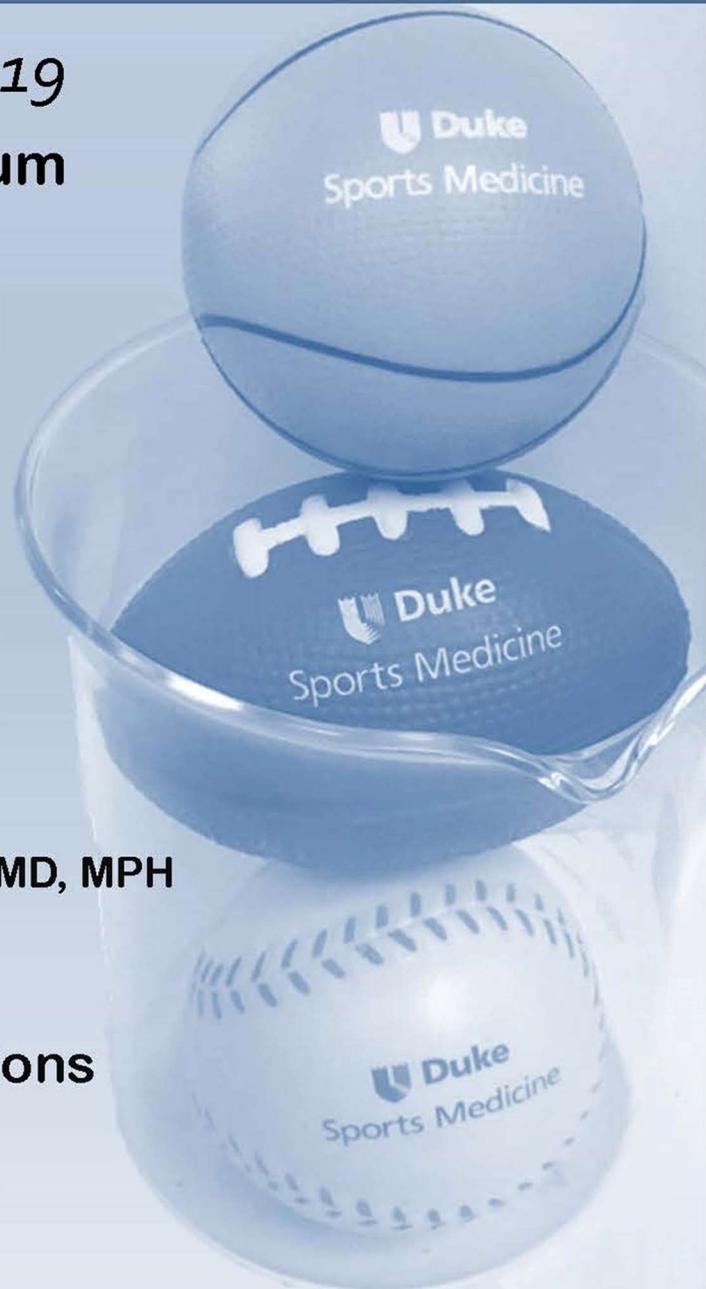
*2:00-2:30 pm*

**Visiting Professor**

**Robert Magnussen, MD, MPH**

*2:45-5:30 pm*

**Research Presentations**



**Duke Sports Medicine**

James R. Urbaniak, MD,  
Sports Sciences Institute

Please join us for  
presentations and  
celebration.

**Duke Sports Medicine Research Day**

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**June 14, 2019**

*Keynote Speaker*



**Robert Magnussen, MD, MPH**

*Associate Professor of Clinical Orthopaedics; Sports Medicine*

*The Ohio State University*

*Letters to a younger scientist:*

*A few thoughts on academics and research*

**Stedman Auditorium**

**2:00-2:30 PM**

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## Duke Sports Medicine Research Day

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### Stedman Auditorium

2:00-2:30: [Robert Magnussen, MD, MPH; Visiting Professor](#); *Letters to a younger scientist: A few thoughts on academics and research*

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### Stedman Auditorium

2:40-2:45: Welcoming remarks

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2:45-3:00: [Andrea C Gist, MD](#); *Does a Concussion Education Program Improve Concussion Knowledge and Safety attitudes in Junior High and High School Rodeo Athletes?*

3:00-3:15: [Lorena Bejarano-Pineda, MD](#); *Association of Injury and Abnormal Findings on Preseason Knee Magnetic Resonance Imaging in Division I Basketball Players*

3:15-3:30: [John L LaRue, PT, DPT, CSCS](#); *The Acute Effect of Throwing Weighted Baseballs on Axillary Artery Blood Flow in High School Male Baseball Players Using Duplex Ultrasonography*

3:30-3:45: [Leslie Pendery Ellis, MD](#); *Fear of Injury Following Concussion and its Relationship to Stability and Dual Task Tests*

3:45-4:00: [Tyler R Johnston, MD](#); *Biomechanical comparison of femoral fixation techniques for Medial Patellofemoral Ligament reconstruction: anchor vs interference fixation*

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4:15-4:30: [Anthony S Ceraulo, DO](#); *Evaluating PROMIS: A QI Perspective*

4:30-4:45: [Bonnie P Gregory, MD](#); *Few Young Patients Meet Return to Play Criteria at 6 Months after ACL Reconstruction*

4:45-5:00: [Christopher R Lefever, PT, DPT, SCS, CSCS, USAW](#); *Characterizing Changes in Knee Kinematics and Strength Following an Experimental Knee Joint Effusion*

5:00-5:15: [Nicholas Michols, DO, ATC](#) ; *Clavicle Fracture Decision Making: Should Bilateral AP Films Be Standard*

5:15-5:30: [Brian C Lau, MD](#); *Shoulder Instability: First-Time, Recurrent, Revision: How are we doing? How do we decide? Where do we go now?*

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5:30-5:35: Closing remarks, followed by photography for fellows and faculty

*Does a Concussion Education Program Improve Concussion Knowledge and Safety Attitudes in Junior High and High School Rodeo Athletes?* Gist AC, Ray TR, Bytomski J, Reinke EK

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**Objective:** Recent emphasis on proper concussion management has increased concussion education and research in many sports. Concussion is thought to comprise 8-15% of all rodeo injuries, yet junior high and high school rodeo athletes receive no formal education on concussions. The primary objective of this observational cohort study was to determine if a concussion education program was effective in increasing knowledge about concussions in members of the National Junior High and High School Rodeo Association. The secondary objective of the study was to determine if this education program changed attitudes about injury reporting and use of safety equipment.

**Methods:** Contestants present at a series of mandatory contestant meetings filled out surveys before, directly after, and at the end of the season while undergoing a concussion education program. After the initial education, they were given water bottles and business cards with concussion slogans on them. The data from the surveys was analyzed using R statistical analysis software.

**Results:** Sixty-five contestants completed the pre education survey, and fifty-six completed the post education survey. Of this cohort, 63% of athletes reported previous concussion education of some kind. Of the athletes surveyed, 81% reported at least one previous “bell ringer” event, 53% reported at least one likely concussion, and 46% had reported a possible concussive event to a supervising adult. A concussion protocol had been completed by 39% of the athletes.

Concussion education improved knowledge about positive concussion symptoms, most notably amnesia, insomnia, and unconsciousness. Athletes were able to recognize the concern for headache/dizziness after a blow to the head ( $p=0.021$ ), need for avoidance of activity while showing signs of concussion ( $p=0.013$ ), and importance of concussion prevention education ( $p=0.032$ ). Athletes had significant improvement in the belief that reporting concussions is “good” vs “bad” ( $p= 0.033$ ).

By the end of the season, the athletes felt more likely to report concussion ( $p=0.003$ ), but they thought their parents were less likely to report a concussion ( $p=0.014$ ). When asked for reasons to avoid concussion reporting, 69% of the athletes listed prevention from competition as a deterrent to reporting. The concussion education program did not improve the likelihood that athletes would wear helmets ( $p=0.9$ ).

**Discussion (Limitations):** Most recalled “bell ringer” or possible concussion events in our study were not reported to a supervising adult. Education in this population slightly improved concussion knowledge and willingness to report concussions, but there was no increase in the likelihood of helmet usage. This is a difficult population to educate given competition setting, novelty of concussion education, and the “cowboy tough” attitude. This population would benefit from regular ongoing education or possibly a different format of education. Both rodeo administrators and clinicians should make concussion education a priority to better manage and prevent concussive injuries in these young athletes.

**Introduction:** Basketball is a sport with a high prevalence of lower limb injuries. About 15-20% of injuries reported in basketball athletes occur in the knee. Previous studies have shown high rates of abnormal Magnetic Resonance Imaging (MRI) findings among high-level athletes. However, whether these findings have relation to acute or overuse injuries during the season is not clearly understood. The purposes of this study were to describe the incidence of abnormal preseason MRI findings and their association to in-season injuries in elite basketball players.

**Methods:** This is a retrospective study. A total of 27 division I male basketball players over 5 seasons from 2014 to 2019 were included in the study. Bilateral preseason knee MRIs were performed on a 3.0-T magnet. Two players were excluded from the study because their MRIs were performed after the season had started. All imaging studies were reviewed by a musculoskeletal radiologist and a sports medicine orthopedic fellow. Any abnormal findings detected on MRI were described. All subsequently reported musculoskeletal injuries that required conservative or surgical treatment were recorded and included in the analysis. The correlation between MRI findings and the type of injury were also analyzed.

**Results:** A total of 72 preseason knee MRIs were included in the study. Eight athletes played in more than one season. Abnormal findings were found in 59 (81.9%) of the knees. The most common findings were chondral lesions in 38 knees (52.8) and patellar tendinopathy in 30 knees (41.7%). The mean minutes played per season was 522 (SD 462). There was no significant difference in time played between the group of players with positive MRI findings and the group without abnormal findings: 533 (SD 461) vs 452 (SD 491) minutes, respectively. Twelve injuries in ten players were reported.

During the season, five athletes were diagnosed with patellar tendinitis, two had symptomatic osteochondral lesions, and two had lateral meniscus tears. The other three injuries consisted of a subchondral fracture of the femoral lateral condyle, a grade 1 medial collateral ligament sprain, and grade 1 lateral collateral ligament sprain. The osteochondral lesions that became symptomatic all involved the patellofemoral joint. Two patients required surgical treatment, a patient with a meniscus tear and a patient with osteochondral lesion. The remaining ten injuries (83.3%) were resolved with conservative treatment. Of the abnormal findings identified on preseason MRI, 15.2% (9/59) became symptomatic and required treatment during the season.

**Conclusion:** There is a high incidence of abnormal knee MRI findings in division I basketball players. Osteochondral lesions and overuse injuries such as patellar tendinopathy are common knee pathologies in this population. Further investigation is required to determine if preventive rehabilitation protocols guided by the MRI findings could decrease the impact of these injuries in the long term.

*The Acute Effect of Throwing Weighted Baseballs on Axillary Artery Blood Flow in High School Male Baseball Players Using Duplex Ultrasonography; LaRue JL, Myers H, Pietrosimone L*

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**Purpose/Hypothesis:** The primary purpose of this study was to determine the acute effect of throwing weighted baseballs (WB) compared to throwing standard-weight baseballs (SB) on axillary artery blood flow in high school male baseball players. We hypothesized that throwing WB would acutely decrease axillary artery blood flow compared to SB. The secondary purpose was to determine the acute effect of the two throwing conditions on shoulder internal and external range of motion (ROM). We hypothesized that WB would acutely cause a greater increase in external rotation and greater decrease in internal rotation compared to the SB condition.

**Number of Subjects:** 5 high school male baseball players.

**Materials/Methods:** Prior to enrollment, each participant (and his parent if <18 years old) completed informed consent. Each participant completed in two testing episodes, one WB and one SB, separated by 48 hours. Following collection of baseline outcome measures, participants completed a standardized warm-up session. The order of test conditions (SB and WB) were randomized a priori. The SB condition included a throwing session of 30 total throws with a 5 oz. standard baseball. The WB condition included a throwing session of 30 total throws with a 7 oz. baseball (15 throws) and a 14 oz. baseball (15 throws). Outcome measures included ultrasound (US) measurement of axillary artery blood flow using peak systolic velocity (cm/sec), axillary arterial diameter (cm), and passive shoulder external and internal rotation ROM (degrees). Paired-samples *t* tests were utilized to compare change scores (post-throwing value – pre-throwing value) for all dependent outcome variables between conditions (SB vs. WB). For all analyses, statistical significance was set a priori at  $\alpha < 0.05$ .

**Results:** Five male baseball players (age:  $16.40 \pm 1.67$  years; height:  $1.82 \pm 0.08$  m; weight:  $75.93 \pm 15.33$  kg) completed all portions of the study. The average years playing baseball was  $10.00 \pm 3.24$ , while the average years of pitching was  $3.40 \pm 3.72$ . The mean change in axillary artery blood flow (peak systolic velocity:  $-6.774 \pm 11.617$  cm/sec) was not statistically significant between throwing conditions ( $t_4 = -1.304$ ,  $p = 0.262$ ). The mean change in the axillary artery diameter ( $8.823 \pm 19.778$  cm) was not statistically significant between conditions ( $t_4 = 0.99$ ,  $p = 0.375$ ). There were no statistically significant differences in external rotation ROM (mean change:  $-0.467 \pm 12.075$  degrees,  $t_4 = -0.086$ ,  $p = 0.935$ ) or internal rotation ROM (mean change:  $-1.733 \pm 7.243$  degrees,  $t_4 = -0.535$ ,  $p = 0.621$ ) between throwing conditions.

**Conclusions/Study Limitations:** There were no acute effects of throwing WB compared to SB on axillary artery blood flow, arterial diameter, or shoulder internal and external rotation ROM. There was a trend of decreased axillary blood flow following the SB throwing condition but this was not statistically significant. Interestingly, axillary artery blood flow was not reduced in the WB condition, as was hypothesized, but actually showed a trend of increasing following the bout of throwing. In addition to the small sample size, it is possible that 30 throws in each condition was not adequate to elicit a potential change in axillary artery blood flow, diameter, or shoulder rotational ROM in high school male baseball players.

**Clinical Relevance:** The results of this pilot study do not support the hypothesis that throwing WB decrease axillary artery blood flow more than throwing SB. However, this study provides a framework for future investigation. With additional subjects, further research may elucidate the potential benefits and consequences of using WB in training. Establishing the utility of duplex ultrasonography to capture acute changes in axillary artery blood flow that may have a broad impact on both pathology and performance in the overhead throwing athlete.

**Objective:** There are many recent studies demonstrating an increased risk of lower extremity injury following return to sport in athletes that have sustained a concussion<sup>1-4</sup>. The underlying mechanism responsible for this relationship is likely multifaceted. A leading hypothesis is that dual task assessment can be used to identify those at risk for lower extremity injury by better characterizing postural control during dynamic actions<sup>5</sup>. In addition, kinesiophobia (fear of re-injury) has been associated with altered biomechanics and increased risk of re-injury in the ACL literature<sup>6,7</sup>. It is possible that kinesiophobia may be a contributing factor in lower extremity injury in athletes who have sustained a concussion that have been cleared back to sport.

The purpose of our study is two-fold. First, we will determine differences in single and dual task postural stability testing in concussed athletes who are cleared for sport compared to a group of control subjects. We hypothesize that there will be a difference in static and dynamic postural stability testing between concussed athletes who are cleared for sports and controls. Second, we will compare postural stability between high and low kinesiophobia scorers. We hypothesize that a higher kinesiophobia score will be associated with worse degrees of instability.

**Methods:** Healthy athletes, between the ages of 14 and 25 years old with a recent sports related concussion were recruited from Duke Sports Science Institute. Control subjects were age, sex and sports specific matched. Subjects were excluded if they had a history of lower extremity or back surgery. Once cleared by a sports medicine physician to return to sport, subjects underwent static and dynamic postural stability testing with and without a cognitive test (Stroop task) on a single force plate. Static postural stability testing consisted of a single leg stance with eyes open, eyes closed, and dual task. Dynamic postural stability testing consisted of a forward jump over a hurdle with a one-legged landing performed with and without the Stroop task. Variability of the ground reaction force in each direction was calculated, summed and averaged across three trials for each of the static postural stability conditions. A stability index was calculated based on the resultant ground reaction force for the two dynamic postural stability conditions. All subjects were also asked to complete a Tampa Scale for Kinesiophobia (TSK-11) questionnaire. Concussion subjects who scored less than 17 on the TSK-11 were placed in the low score TSK-11 group. Concussion subjects who scored 17 or above on the TSK-11 were placed in the high score TSK-11 group. Statistics were run using STATA software. 37 concussion patients and 17 controls have undergone testing to date.

**Results:** A statistically significant difference was found between the TSK-11 scores between concussion and control groups. No statistically significant difference was found between any of the static postural stability or dynamic postural stability tests when comparing concussed versus controls and TSK-11 high versus low scorers. However, the TSK-11 high scorers did worse on all postural stability and dual task testing.

**Conclusion:** Self-reported fear of re-injury based on the TSK-11 after a concussion may be an important measure to incorporate in the decision to return to sport. Further studies should be performed to better determine the relationship between kinesiophobia and dual task postural stability.

**Limitations:** Our study has several limitations including a relatively small sample size. Furthermore, TSK-11 has been validated in low back pain and other musculoskeletal condition but has not been used in a concussion population. Finally, our dual task testing may not be as challenging to the participants as their sports.

**Background:** Trochlear and notch geometries as well as open physes in pediatric patients limit the safe corridor for femoral interference screw graft fixation during MPFL reconstruction. Accordingly, interest is increasing in alternate fixation techniques, including anchor-based fixation, and these techniques are currently being explored clinically without systematic biomechanical validation.

**Purpose:** The aim of this study was to evaluate biomechanically whether anchor-based femoral MPFL graft fixation is a viable alternative to traditional tenodesis screw technique. Our hypothesis was that anchor-based femoral graft fixation with smaller 3-D footprints can provide comparable graft fixation to traditional tenodesis screw technique with respect to cyclic load-displacement and load-to-failure.

**Study Design:** Controlled laboratory study

**Methods:** 27 fresh-frozen porcine knees (9 per group x 3 groups) were used for biomechanical MPFL reconstruction testing given previously proven similarity to human adolescent knees. Distal femurs were dissected free of overlying soft tissue and potted for testing in an electromechanical load frame, while cadaveric semitendinosus specimens were used for MPFL grafts. Reconstructions were performed using landmark and radiographic identification of Schottle's point and standard technique with one of the three femoral fixation strategies: 4.5mm Corkscrew (CS, biocomposite threaded anchor) double-loaded with 2xSuturetape, 2.6mm Knotless FiberTak (FT, suture-based), or traditional Bio-tenodesis screw (TS, 7x23mm). For biomechanical testing, specimens were oriented in the Instron testing apparatus such that the direction of pull recreated the normal trajectory of the MPFL, while the free end of the soft tissue graft was secured to the cross-head using an interdigitizing freeze clamp. Each specimen was preconditioned for 10 cycles of cyclic loading between 5 and 20N at 1Hz, followed by 1000 cycles of loading between 5 and 100N at 1Hz. Lastly, load-to-failure testing was performed at 20mm/min. Time, displacement and load data was recorded continuously (at 95Hz) and used to report stiffness and construct lengthening across 100, 500 and 1000 cycles of loading. Average construct stiffness, elongation (displacement) over cyclic loading at 100, 500, 1000 cycles, and load-to-failure data between the 3 groups were compared analysis of variance (ANOVA) with significance level set at  $p < 0.05$ . A test of equivalence of means was used to evaluate whether the 3 fixation strategies were equivalent with respect to force-displacements and load-to-failure.

**Results:** Pilot testing was completed with 3 specimens from each group: TS, CS, and FT. Construct stiffness (N/mm) at 100 and 1000 cycles were comparable: TS group  $111.2 \pm 19.8$  at 100 cycles and  $138.7 \pm 21.9$  at 1000 cycles; CS group  $127.3 \pm 27.7$  at 100 cycles and  $131.3 \pm 8.6$  at 1000 cycles; FT group  $99.1 \pm 6.6$  at 100 cycles and  $111.7$  at 1000 cycles. Construct displacements (mm) at 100 and 1000 cycles were also comparable: TS  $7.4 \pm 3.2$  at 100 cycles and  $9.6 \pm 4.5$  at 1000 cycles; CS  $8.1 \pm 0.4$  at 100 cycles and  $10.9 \pm 1.2$  at 1000 cycles; FT  $6.5 \pm 3.0$  at 100 cycles and  $13.3$  at 1000 cycles. There was no statistically significant difference between ultimate loads between groups: IS  $331.4 \pm 99.9$ N, CS  $282 \pm 17.8$ N, FT  $303.3$ N. However, 2/3 Fibertak specimen constructs and 1/3 CS specimens failed before 1000 cycles, while all TS constructs withstood all testing.

**Conclusion:** Traditional interference screw fixation remains standard-of-care for femoral-side fixation of MPFL reconstructions, but this technique is not without downsides, and anchor-based fixation presents opportunities to reduce fixation footprint and potential for physal/ notch violation. The results of the pilot data demonstrate similar load-displacement characteristics of all 3 types of fixation constructs, but a reduced ability of anchor-based constructs to withstand cyclic loading, particularly for all-suture anchors with 66% failure over less than 1000 cycles. Accordingly, for our follow-up complete study of 9 specimens/constructs per group we will focus on optimizing anchor-based fixation by testing anchors with improved resistance to shear loads (4.5 Corkscrew and 3.5 Knotless Corkscrew).

# Duke Sports Medicine Research Day

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*HALF TIME*



*HALF TIME*

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**Objective:** Within the Department of Orthopedic Surgery at Duke University, the PROMIS (Patient Reported Outcomes Measurement Information System) survey has been implemented for the purpose of functional data collection to further departmental research interests. The PROMIS survey is a validated patient reported outcome tool that assesses multidimensional factors: pain, physical function, sleep disturbance and depression. Much effort has gone into implementing this survey, and great strides have been made. Continuing to strive to maximize useful data collection could significantly increase our ease of access to functional research. Our hypothesis stands that while PROMIS implementation is highly useful to clinical research, the current manner of implementation could be improved for optimal utilization of the collected data.

**Methods:** PROMIS surveys are assigned on Monday mornings to new patient visits scheduled within the next two weeks. Data is collected within MyChart or in clinic on Welcome tablets. Once a patient completes the survey, follow-up surveys are triggered 6 weeks then 3, 6, 9, and 12 months from the initial date of completion. Data compiled on all assigned surveys includes data from the initial encounter, performed procedures, attached diagnoses, and any completed survey data. An extract from this database was collected using various common procedure codes highly relevant to sports medicine, including those for ACL reconstruction, rotator cuff repair, knee arthroscopy, ultrasound guided injections of both corticosteroid and PRP, as well as adipose-derived stem cell injection procedure codes. The temporal relationship between the procedural intervention and the assessed PROMIS surveys was assessed and compared against requested 'timestamp' intervals.

**Results:** The data generally showed the following amongst all assessed CPT codes: 1) the number of survey respondents decreased significantly from each time interval with each procedure; 2) while the median values remained somewhat correlated to the 'timestamp' goal, the range of data collected at each interval was wide, often consisting of >100 days. A pre and post procedure PROMIS was found at these rates: ACL – 16%, shoulder arthroscopy – 15%, knee arthroscopy- 10%, stem cell – 9%, PRP – 9%, US injection of large joint – 9%. 46% of the time the provider performing procedure triggered the utilized PROMIS.

**Discussion:** At this point, it appears that overall PROMIS implementation has made significant strides in survey completion percentages and accessibility within the department. However, there is still work to be done to maximize the usefulness of this data and its use toward functional research. The largest hurdle of initiating the system on a department-wise basis has been successful and has helped us see next steps. First, from a data reporting standpoint within our current system it may be most functional to report data in 'windows' rather than 'timestamps'. Secondly, the concept of universal triggering of PROMIS could be reassessed to create a limited number of situations that trigger the survey. While this may be technically challenging to coordinate with staff, it will avoid the significant provider overlap leading to multiple confounding survey triggers, a factor that appears significantly implicated in rendering much of the current data difficult to use. Further, most of our progress in terms of increased collection has been made in initial survey completion. From here, future efforts still need to be focus on finding efficacious ways to increase post-procedural survey completion, possibly through an incentive-based system for patients if the data is truly desired. Additionally from an observational standpoint, upon review of the collected survey data there seems to be significant opportunity to better utilize some of the quantifiable psychosocial factors affecting patient outcomes. With ancillary factors seen in PROMIS such as the relatively high number of moderate to severe depression reported, further study could look to assess the impact of something like routine multi-specialty involvement post-procedurally to assess for effect on outcomes. The point of this QI analysis is ultimately to start a conversation, and to continue to strive toward both access to outcome data and the efficiency of clinical research within our department.

## *Few Young Patients Meet Return to Play Criteria at 6 Months after ACL Reconstruction;*

Gregory BP, Magill JR, Meyers H, Le DT, Reinke EK, Riboh JC

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**Introduction:** Despite hundreds of studies reporting on various criteria for safe return to sport, no consensus exists on optimal timing or physical performance testing (PPT). Additionally, ACL re-tear and contralateral tear rates continue to be problematic, especially in the young athlete. This study aims to evaluate readiness to return to sport by utilizing a concise, but comprehensive battery of the most commonly utilized return to play tests. We hypothesize that scoring >90% on side-to-side comparisons of all tests in the battery will indicate neuromuscular readiness to return to sport and that the majority of patient will not achieve this by 6 months post-surgery.

**Methods:** A retrospective review of 68 consecutive patients between age 6 to 40 years of age (mean=19+/-8 years; 54% male, 46% female) who underwent ACL reconstruction by a single surgeon from February 2016 to November 2018 and completed a series of functional physical performance tests to assess readiness to return to play was conducted. A chart review of demographic data including age, gender, body mass index (BMI), and primary sport played, as well as surgical details including graft type, concomitant meniscal injury, and primary vs. revision status was conducted. In the presence of a physical therapist, all patients performed nine common PPT's including the stork balance, stork balance on BOSU, single leg squat (SLS), SLS on BOSU, clockwise and counterclockwise quadrant single leg hop (SLH), forward SLH, timed SLH, and triple crossover SLH. A composite score for each limb on each test was developed by averaging trials. This mean was used to obtain a percentage side-to-side difference for each test (%STS). Ninety percent STS was used as the cut-off for passing each individual test. Multivariate linear regression analyses were performed to assess the effect of age, gender, graft type, concomitant meniscal surgery, and time post-op at which the testing was conducted on %STS of each individual test. Patients were excluded from the study for concomitant lower extremity injury, neuromuscular disorder, pregnancy, inability or unwillingness to consent, and inability or unwillingness to complete return to play testing.

**Results:** A total of 61 of 68 patients (90%) completed all nine PPTs at a mean 202.7 days (+/- 58) post-surgery. Only 11 of 68 (16%) of patients passed all nine tests on initial testing, with only 11% of patients 16 years of age or younger passing all tests compared to 26% of patients 17 years of age or older passing all. When passing rate based on graft type was analyzed, 40% of quadriceps tendon autografts, 15% of bone patellar tendon bone (BTB) autografts, 10% hamstring autograft, and 0% of iliotibial band autografts patients were successful at passing all nine tests. The 90% STS cut-off for each test resulting in the following individual test pass rates: 97% for stork balance, 88% for stork balance on BOSU, 81% for SLS, 75% for SLS on BOSU, 50% for clockwise quadrant SLH and 41% counterclockwise quadrant SLH, 46% for forward SLH, 81% for timed SLH, and 53% for triple crossover SLH. Multivariate regressions demonstrated that age, gender, concomitant meniscal surgery, and time post-op testing was conducted were poor predictors of passing individual PPTs with a few exceptions. Age was a negative independent predictor of 90% STS for the stork balance on Bosu ( $p=0.031$ ) and SLS on Bosu ( $P=0.026$ ) tests. Iliotibial band autograft compared to BTB autograft was an independent predictor of passing SLS ( $p=0.026$ ). Significantly, quadriceps tendon autograft was an independent predictor of how many tests an individual will pass ( $p=0.017$ ) on multivariate regression.

**Conclusion:** In recent years, several studies have concluded that early return to sport is associated with ipsi- and contralateral ACL tear as well as increased ACL graft injuries when patient are released before passing return to sport testing (Grindem et al, Sousa et al, Dekker et al, Losciale et al). Our study confirms that at an average of 6.78 months the majority of patients fail to achieve the >90% SLS passing rate on this comprehensive series of PPTs. In fact, only 11% of young patients passed all nine tests, compared to 26% of patients 17 years or older. Additionally, this study shows that quadriceps tendon autograft is a promising graft choice for earlier success on return to play testing.

## Characterizing Changes in Quadriceps and Hamstring Strength Following an Experimental Knee Joint Effusion; Lefever CR, Pietrosimone L, Myers H, Sell TC

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**Purpose/Hypothesis:** Following rehabilitation, a percentage of patients revert to aberrant gait mechanics and associated impairments. The ability to understand post-injury walking gait and strength changes is critical to improve long term care of these patients, as these variables are associated with both an inability to return to pre-injury level of activity and early development of osteoarthritis. Therefore, the purpose of this study was to determine the effects of an experimental knee joint effusion on quadriceps and hamstring strength in healthy adults. We hypothesized that the effusion would elicit a reduction in both quadriceps and hamstring isometric strength.

**Number of Subjects:** 5 healthy adult participants.

**Materials/Methods:** Quadriceps and hamstring strength was assessed using the Biodex System III Pro Dynamometer (Biodex Medical Systems, Shirley NY) at a knee flexion angle of 60 degrees; the pelvis and torso were stabilized against the chair using adjustable straps and the arms folded across the chest during testing. Participants performed five trials of a maximum voluntary isometric contraction (MVIC) on the tested limb before and after the joint effusion. Peak torque normalized to body weight ( $\text{N}\cdot\text{m}\cdot\text{kg}^{-1}$ ) from the five trials was recorded and utilized for analysis. Paired-sample *t* tests were used to assess changes quadriceps and hamstring MVIC, respectively, of the involved lower extremity (effused knee), across the two time points (pre- and post-effusion). Statistical significance was established *a priori* at  $\alpha=0.05$ . Cohen's *d* effect sizes were classified as weak ( $d \leq 0.2$ ), small ( $d = 0.2-0.5$ ), moderate ( $d = 0.5-0.8$ ), or large ( $d \geq 0.8$ ).

**Results:** Five healthy adult participants (4 male, 1 female; age:  $26 \pm 3.52$  years; height:  $171.6 \pm 10.92$  m; weight:  $76.65 \pm 9.25$  kg) completed the study. There was a statistically significant reduction in normalized quadriceps MVIC from pre-effusion ( $2.49 \pm 0.30 \text{ N}\cdot\text{m}\cdot\text{kg}^{-1}$ ) to post-effusion ( $1.72 \pm 0.38 \text{ N}\cdot\text{m}\cdot\text{kg}^{-1}$ ) (mean difference:  $0.77 \pm 0.39 \text{ N}\cdot\text{m}\cdot\text{kg}^{-1}$ ; 95% CI: 0.35, 1.19;  $t_4 = 5.08$ ,  $p = 0.007$ ) which demonstrated a large effect (Cohen's  $d = 2.23$ ). There was also a statistically significant reduction in normalized hamstring MVIC from pre-effusion ( $1.08 \pm 0.11 \text{ N}\cdot\text{m}\cdot\text{kg}^{-1}$ ) to post-effusion ( $0.86 \pm 0.15 \text{ N}\cdot\text{m}\cdot\text{kg}^{-1}$ ) (mean difference:  $0.22 \pm 0.18 \text{ N}\cdot\text{m}\cdot\text{kg}^{-1}$ ; 95% CI: 0.002, 0.44;  $t_4 = 2.80$ ,  $p = 0.049$ ) which demonstrated a small effect (Cohen's  $d = 0.33$ ).

**Conclusion:** Following to an experimental knee joint effusion, both the quadriceps and hamstring musculature demonstrated decreases in knee flexion and knee extension forces. Effusion secondary to knee joint injury produces arthrogenic muscle inhibition, which has been demonstrated in previous research. Interestingly, our preliminary results also demonstrate a decrease in hamstring isometric strength. This has not been shown in the literature to-date, which has largely remained focused on quadriceps inhibition following effusion.

**Clinical Relevance:** Our preliminary findings confirm the hypothesis of decreased lower extremity strength following an experimental joint effusion, consistent with previous literature. Persistent knee effusion may result in long-term muscular strength impairment, possibly influencing gait mechanics. These data provide early support for our *a priori* hypothesis that altered lower extremity muscle function may lead to changes in walking gait biomechanics. Ongoing investigation of the study aims, particularly whether changes in knee joint function following effusion result in altered gait biomechanics that can be detected with wearable sensor technology, are being pursued.

## *Clavicle Fracture Decision Making: Should Bilateral AP Films Be Standard;*

Michols N, Reinke EK, Le DT, Lutz R, Ray T, Riboh JC

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**Background:** It has been suggested that utilizing a PA thorax radiograph in assessment of shortening in clavicle fractures is most consistent with measurements seen on computed tomography (CT). With the recommendations to perform open reductions and internal fixations on mid-shaft clavicle fractures with 100% displacement and >2cm of shortening it is important to determine if this view can reliably assess shortening among physicians and if this view impacts clinical decision making.

**Purpose:** The purpose of this study is to determine if the additional information provided by the PA thorax impacts clinical decision making for surgical intervention. A secondary goal is to measure the intra and inter tester reliability in measurement of clavicle shortening utilizing a PA thorax radiograph compared to the standard AP and 30 degree cephalad radiographs.

**Study Design:** This is a retrospective cohort study design with preliminary results.

**Methods:** Patients ages 5-80 with concerns for clavicle fracture on clinical exam at Duke Sports Science Institute were identified and standard radiographs, including AP, 30 degree cephalad and PA thorax, which captured both the affected and non-affected clavicle, were reviewed. Fracture management was determined by the provider at the time the films were obtained and will not be impacted by this study. Forty-five radiographs from 16 patients with clavicle fracture with displacement or shortening were stripped of identifying data and placed in randomized order. Physicians with varying levels of training were asked to evaluate each radiograph in randomized order and 1) measure the degree of shortening in millimeters 2) determine the percentage of displacement, and 3) state whether they feel the fracture should be managed surgically or non-surgically.

**Results:** Inter-rater and intra-rater reliabilities were calculated utilizing Fleiss' kappa statistic. The overall recommendation for surgical intervention had a kappa of 36% in agreement among raters, reported by image view was 38.2%, 48%, and 21.6% for AP, Axial, and Bilateral respectively. The kappa for displacement was 52.2% among raters, broken down by image view 15.4%, 61.8%, and 53.1% for AP, Axial, and Bilateral respectively. The intraclass correlation coefficient (ICC) for measurement of fracture shortening was most notable at 68.2% for consistency, broken down by image view 68.4%, 71.2%, and 66.9% for AP, Axial, and Bilateral respectively. Further details of the preliminary results are pending for further completion.

**Conclusion:** Preliminary data reports a low surgical inter-rater agreement, which follows the history of treatment variability of clavicle fractures. In this study measuring of clavicle fractures is completed with good consistency, were as agreement in determination of displacement percentage is variable. Overall the Axial plain film view reported the greatest kappa or ICC value. This preliminary data supports the need for a consensus on treatment recommendations in clavicle fracture.

*What Drives Decision-Making in Surgical Treatment of Recurrent Anterior Shoulder Instability? A Discrete Choice Experiment;* Lau BC, Hutyra CA, Gonzalez JM, Mather RC 3<sup>rd</sup>, Riboh JC

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**Objective:** The optimal surgical approach for recurrent anterior shoulder instability remains a source of debate, particularly in the face of glenoid, humeral or bipolar bone loss. The purpose of this study was to utilize a contingent-behavior questionnaire (CBQ) to determine which factors drive surgeons to perform bony procedures over soft tissue procedures to address recurrent anterior shoulder instability. CBQs are stated-preference instruments used in health to study the relative importance of various factors (attributes) as patients, physicians and other stakeholders make choices between options.

**Methods:** A CBQ was designed to examine how orthopedic surgeons use patient demographics and clinical factors when choosing a surgical technique for recurrent anterior instability. Questions in the CBQ were designed using a balanced incomplete block design. The survey presented each respondents with 32 clinical vignettes of recurrent shoulder instability that contained 8 patient factors (attributes) that could assume one of several levels under each attribute. The attributes included: 1) age, 2) sex, 3) hand dominance, 4) number of previous dislocations, 5) activity level, 6) generalized laxity, 7) glenoid bone loss, and 8) glenoid track. The survey was distributed to shoulder/elbow and sports medicine trained attending surgeons. Respondents were asked to broadly recommend either a soft tissue or bone-based procedure, then specifically recommend arthroscopic labral repair, arthroscopic labral repair with Remplissage, open Bankart repair, coracoid transfer, or free bone-block augmentation. Responses were analyzed using a multinomial-logit regression model that quantified the relative importance of the patient characteristics in choosing bony procedures.

**Results:** 70 orthopedic surgeons completed the survey, 33 were shoulder/elbow fellowship trained and 37 were sports medicine fellowship trained. 52% were in clinical practice  $\geq 10$  years and 48%  $<10$  years, and 95% reported that the shoulder surgery made up at least 25% of their practice. There were 53% from private practice and 33% from academic medicine. Glenoid bone loss was the single most important factor driving surgeons to perform bony procedures over soft tissue procedures, followed by the patient age and the patient activity level. Interestingly, number of prior dislocations and glenoid track status did not have a strong influence on respondents' decision making. Younger age ( $< 18$  years) was a strong influence toward arthroscopic soft tissue techniques. Shoulder/elbow trained surgeons were more likely to recommend bony procedures compared to sports fellowship trained surgeons ( $p<0.001$ ). There was no difference in treatment recommendations between those in practice  $<10$  years compared to those with  $\geq 10$  years of experience ( $p=0.057$ ) or between low and high-volume arthroscopic providers annually ( $p=0.750$ ).

**Conclusion:** The factors that drove surgeons to choose bony procedures were the amount of glenoid bone loss, the patients' age and their activity demands. Surprisingly, glenoid track status and the number of previous dislocations did not strongly influence surgical treatment decisions. Shoulder/elbow fellowship trained surgeons were more likely to recommend bony surgical treatment than their sports trained colleagues. There was no difference in treatment recommendations between those in practice  $<10$  years compared to those with  $\geq 10$  years of experience or between low and high-volume arthroscopic providers.

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*For Dr. Bill Garrett, our friend and mentor, who loved Sports Medicine and research.*

