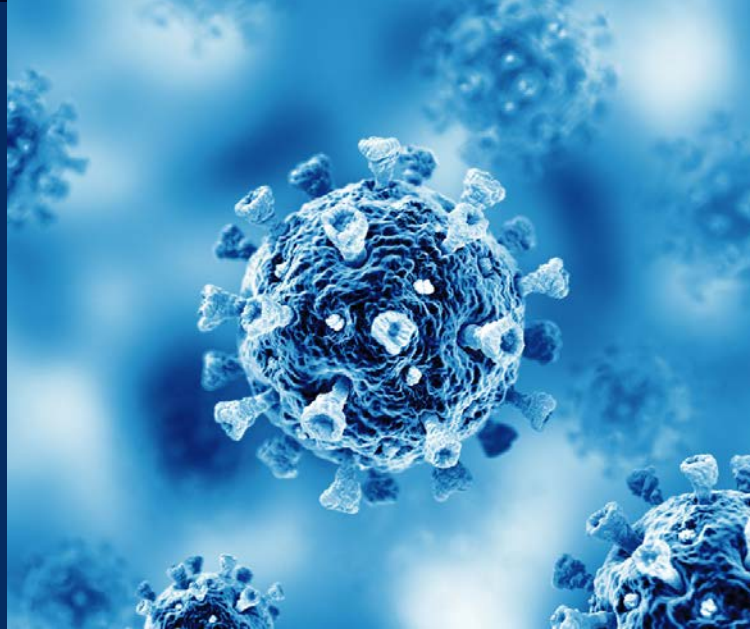




DUKE SPORTS MEDICINE



**2ND ANNUAL
WILLIAM E. GARRETT, Jr, MD, PhD
SPORTS MEDICINE
RESEARCH DAY**

JUNE 23, 2021

Dr. William E. Garrett, Jr, MD, PhD



April 23, 1949–May 4, 2019

Dr. Garrett was a consummate physician, clinician–scientist, and teacher during his 40+ years of service to Duke University Medical Center and his patients. As a specialist in sports medicine for thirty years, he served as the Medical Director of the U.S. Soccer Federation and Team Physician for the U.S. Men and Women's National Soccer teams, as well as many Duke teams. As a teacher, he has the unique distinction of earning the Outstanding Teacher Award by both the residents at the Duke and UNC Departments of Orthopaedics. He was awarded the Duke Department of Orthopaedic Surgery Master Orthopaedist Award. Posthumously, Dr. Garrett was inducted into the AOSSM Hall of Fame. Dr. Garrett's research awards include the Kappa Delta Award (ORS), Citation Award (ACSM), the Award of Merit (AOSSM), Excellence in Research in the Category of Basic Science (AOSSM), the Excellence in Research Award (AOSSM), the O'Donoghue Award (AOSSM). It is his friendship, mentorship, and love of research and Sports Medicine we honor at this event.

Dr. William E. Garrett, Jr. Visiting Professor

Louis E. DeFrate, PhD

Dr. DeFrate is the Frank H. Bassett III, M.D. Professor of Orthopaedic Surgery and holds appointments in the Department of Mechanical Engineering and Materials Science and the Department of Biomedical Engineering. Dr. DeFrate is the Vice Chair Biomechanics, Movement, and Imaging Research for the Department of Orthopaedic Surgery.

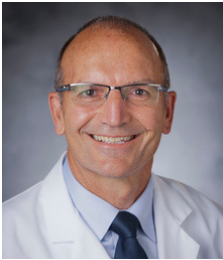


Dr. DeFrate completed his Sc.D. in Mechanical Engineering from the Massachusetts Institute of Technology in 2005. He spent one year on the faculty at Harvard Medical School prior to joining Duke in 2006. Dr. DeFrate's research focuses on the application of engineering principles to investigate clinically relevant problems related to the musculoskeletal system, with a particular interest in biomechanics (the study of forces and motion in living organisms) and imaging. His work in this area has been acknowledged by the 2016 Kappa Delta Young Investigator Award from the American Academy of Orthopaedic Surgeons (AAOS) and the Orthopaedic Research Society (ORS). Dr. DeFrate is currently the principal investigator of three NIH R01 grants related to the biomechanics of the knee and spine totaling approximately 1.6 million dollars per year.

Elizabeth Pennington, RN

Elizabeth (Libby) Pennington is retiring after 30 years of service to Duke and 25 years to Duke Sports Medicine. She was an integral part of Dr. Garrett's clinical team, and due to his passion for research, she became an integral part of the Sports Medicine Research team as well. We have benefitted more than she realizes from her knowledge, experience, care, and calm and are honored to acknowledge her contributions today.

PRESENTATIONS



Opening Remarks and Retirement Presentation

Annunziato (Ned) Amendola, MD, Professor of Orthopaedic Surgery; Chief, Division of Sports Medicine; Director, Urbaniak Sports Sciences institute



Keynote

Louis E. DeFrate, PhD

Unravelling the mysteries of ACL Biomechanics Part II:
Investigating ACL Injury Mechanisms



Sarah T. Lander, MD

Validation of 3D MRI in Glenohumeral Instability Evaluation of Glenoid and Humeral Bone Loss and Glenoid Tracking Compared to CT Scan



Daniel Lynch, PT, DPT, SCS, LAT, ATC, MTC

Perseverance after ACL Reconstruction



Brent Pickett, DO

Association between Achilles Tendinopathy and Metabolic Disease: A Systematic Review



Robert A. Christian, MD, MBA

VTE Prophylaxis and Hormonal Contraceptive Use During the Perioperative Period for Anterior Cruciate Ligament Reconstruction: a Survey of the AANA Membership

PRESENTATIONS



Drew Lukes, PT, DPT, CSCS

Two-Year Performance and Self-Reported Function Characteristics of Individuals following Primary Anterior Cruciate Ligament Reconstruction



Benjamin Ferry, MD

The Association between Orthostatic Vital Signs and Return-to-Play after Concussion



Caitlin Rugg, MD

The Effect of COVID19 on Collegiate Athlete Readiness to Play and Injury Rates



Tommy Otley, PT, DPT, CSCS

Sink or Swim? What Clinical Objective Tests and Measures are Associated with Pain and Injury in Swimmers? A Systematic Review



Eric Friedman, MD

COVID Affects Your Lungs, Blood, Politics, and Even TRAINING ROOM



Christopher L. Shultz, MD

The Path to Perfection: A Systematic Review of Learning Curves in Sports Surgery

ABSTRACTS

Validation of 3D MRI in Glenohumeral Instability Evaluation of Glenoid and Humeral Bone Loss and Glenoid Tracking Compared to CT scan

Lander SL, Liles J, Taylor D, Lau BC

Background: There is increasing understanding of the importance of glenoid, as well as humeral bone loss in outcomes and surgical decision-making in shoulder instability. Although magnetic resonance imaging (MRI) is performed as standard of care for evaluation of shoulder instability, CT scan remains the gold standard in bony measurements. Standard MRI evaluation has been shown to inaccurately measure bone loss. However, additional CT scans result in increased financial as well as radiation cost to the patient.

Objectives: To determine whether the addition of 3D MRI to standard MRI sequences is comparable to CT scan evaluation of glenoid and humeral bone loss in glenohumeral instability.

Methods: Twelve patients who presented with glenohumeral instability were prospectively enrolled and received both MRI and CT within 1 week of each other. The MRI included an additional sequence (VIBE) which underwent post-processing for reformations (See Figure 1a). CT data also underwent 3D post-processing and therefore each patient had four imaging modalities (2D CT, 2D MRI, 3D CT reformats, and 3D MRI reformats). Each sequence underwent the following measurements from two separate reviewers: glenoid defect, glenoid defect percent, humeral defect, and humeral defect percentage, and evaluation of glenoid track. 3D CT and MRI also underwent evaluation of percent humeral head loss. Paired t-tests were used to assess differences between imaging modalities and chi squared for glenoid track. Intra-observer and interobserver reliability were evaluated. Bland-altman tests were also performed to assess the agreement between CT and MRI.

Results: 3D MRI measurements for glenoid and humeral bone loss measurements were comparable to 3D CT. There were no significant differences glenoid defect size or percentage, or humeral defect size or percentage ($P>0.05$). Bland-Altman analysis demonstrated strong agreement for 3D CT and 3D MRI percentage glenoid bone loss. There was also no difference in evaluation for determining on vs off track between any of the imaging modalities. Inter- and intra-rater reliability was good to excellent for all CT and MRI measurements.

Conclusion: 3D MRI measurements for bone loss in glenohumeral instability through utilization of VIBE sequence were equivalent to 3D CT. 3D MRI may be a useful adjuvant to standard MRI sequences for more accurate assessment of glenoid and humeral bone loss in glenohumeral instability. Further assessment of financial, as well as surgical decision making between with the use of 3D MRI and 3D CT scan are warranted.

ABSTRACTS

Perseverance Following Anterior Cruciate Ligament Reconstruction

Lynch D, Lentz T, Pietrosimone LS

Background & Purpose: Anterior cruciate ligament reconstruction (ACLR) is one of the highest researched topics in sports medicine, due to its prevalence and the consequential short- and long-term effects on sport participation and quality of life. Previous research has evaluated patient physical characteristics paired with patient-related subjective outcomes (PRO) to comprehensively understand outcomes following ACLR. Factors such as poor muscle function and lower patient-reported outcomes taken early and late after ACLR relate to poor clinical outcome. Psychological characteristics following ACLR, such as those of personal, social, and contextual influence, influence recovery and return to sport have also been assessed. 3 Another study has shown, decreased self-efficacy and pain-catastrophizing are related to decrease clinical outcomes post ACL. Therefore, it is well understood that post-ACLR rehabilitation for an athlete desiring a return to sport is rigorous both physically and psychologically; however the principles addressing perseverance and resilience have not been considered. A more comprehensive understanding of an athlete's resilience and ability to manage adversity could add value to the recovery process post-ACLR, due to the time and effort required to restore physical and psychological function. Grit represents a resilience-related construct which has not been studied in the ACLR population. Grit is a measurable construct whose assessment has been validated within psychological frameworks and linked to success in various populations.

The Grit scale was developed by Duckworth et al (2007). Grit is defined as a non-cognitive trait, described by the following characteristics: "perseverance and passion for long-term goals"; "working towards challenges, maintaining effort and interest despite failure, adversity, and plateaus in progress"; "capacity to sustain effort and interest in something that takes months or longer to complete". The Grit scale was initially validated in populations of both adults and children through a series of studies, including evaluating its predictive value of educational attainment in adults, GPA and SAT scores in Ivy League students, and performance of children in the Scripps's National Spelling Bee. Most notably, GRIT was the strongest psychological domain to predict completion of the rigorous summer training program and retention in the West Point Academy in two independent cohorts of academy's cadets (Duckworth et al, 2007). The GRIT scale has also been shown to associate with time commitment to practice in alpine skiers and related to improved sport outcome and performance.

Research has not yet established 1) how stable grit is among post-surgical populations undergoing ACLR, 2) whether an individual's baseline grit associates with other common PROs, including other psychological measures, or 3) whether grit predicts performance on common clinical tests/measures utilized for rehabilitation and return to activity decision-making following ACLR. Therefore, the purpose of this study is to determine the efficacy of the GRIT Scale and its potential to predict success in a population of athletes following ACLR. The first aim is to determine if the GRIT scale associates with other common PROs at early time points following ACLR. Our working hypothesis is that higher levels of grit will be associated with less pain intensity, lower levels of pain-related psychological distress, and higher physical function.

ABSTRACTS

Perseverance Following Anterior Cruciate Ligament Reconstruction

Lynch D, Lentz T, Pietrosimone LS (Continued)

Subjects: Males and females ages 13-35 following primary ACLR (all graft types) who report an intention to return to sport at the time of surgery. Exclusion criteria include: 1) have had another ACLR surgery (ipsilateral or contralateral), 2) have had an all-epiphyseal ACLR (pediatric procedure), 3) do not intend to return to pivoting/cutting sport, 4) unable to read or understand English.

Methods: Participants will be enrolled pre-operatively. Any patient who meets the study inclusion criteria at the time of initial visit to the orthopedic surgeon at the Duke Sports Science Institute following ACL injury will be invited to be screened for potential enrollment. All patient-reported data will be collected via REDCap survey, either in-clinic during a regularly scheduled visit or via automated email with a REDCap link. Patient-Reported Outcome Measures will included: GRIT Scale, OSPRO, IKDC, NRS Pain Intensity, MODEMS, ACL-RSI, Tampa Scale of Kinesiophobia, and Marx Activity Scale. These PRO's will be collected at the following timepoints: all taken pre-operative to post-operatively at week 2 then months 3, 6, 9 and 12, respectively. To address primary aim, the Pearson and Spearman's rank correlation tests will be conducted to assess normally and non-normally distributed continuous variables, respectively. The association between continuous variables and dichotomous variables will be analyzed using the Student's t-test and Wilcoxon rank-sum test for normally and non-normally distributed variables, respectively. The association between continuous and categorical variables will be analyzed using the ANOVA and Kruskal-Wallis test for normally and non-normally distributed variables, respectively.

Study Status: In recruitment/enrollment stage. Two patients have agreed to participate at this time (awaiting baseline survey completion).

Clinical Relevance: The post-operative rehabilitation process is long, challenging, and requires sustained effort, interest, and goal orientation. Therefore we believe those who display high levels of perseverance (higher Grit scores) will be more likely to be able to overcome the multiple barriers to successfully return to sport and meet the rigorous return to sport criteria. This baseline study is designed to guide future directions for the utility of the Grit Scale as an outcome measure. Validation of Grit scores in the ACLR population may prove to be a useful outcome measure to help individualize goal setting, temper or predict clinical expectations, and prove to be a prognostic variable for long courses of ACLR rehabilitation. Future directions would be to identify low Grit score relationships to poor physical performance with RTP battery testing. There may even be an initiative to explore potential interventional aspects to positively influence grit.

ABSTRACTS

Association between Achilles tendinopathy and metabolic disease: a systematic review.

Pickett B, Friedman E, Ferry B, Hendren S, Cook C, Anakwenze O, Ceraulo A

Background: Achilles tendon pain is a common presenting complaint in orthopedic clinics with Achilles tendinopathy (AT) representing a frequent diagnosis as a cause of chronic Achilles tendon pain. Several studies have been done in order to analyze the etiology of AT. Several etiologic factors have been considered in the literature: mechanical, biochemical, metabolic, hereditary, and medication side-effect, among others. A number of these studies have been performed in order to examine the relationship between metabolic disease and AT.

Purpose: The purpose of this systematic review is to examine the relationship between diabetes mellitus (DM), hypertension (HTN), hyperlipidemia (HLD), and thyroid derangements (TD), including hyper-/hypothyroidism and AT.

Methods: A literature search was performed using a search query of relevant literature databases with search terms to include adult patients with AT and concomitant DM, HTN, HLD, and TD. 929 studies, after removal of duplicates, were included for initial screening. 855 of these were deemed to be irrelevant upon review of abstract. 71 studies were included for full-text review. 66 of these studies were excluded from proceeding to final statistical analysis.

Results: Statistical analysis demonstrated the following: DM: N=523, OR 0.35, CI 0.19-0.63, p value<0.01 HLD: N=913. OR 8.68 95% CI: 5.97, 12.41. p value<0.01. HTN: N=400 OR 2.45. 95% CI 1.39-4.32. p value <0.01. TDs: N=433. OR 280.12. 95% CI 110.85-707.84. p value<0.01.

Conclusion: Statistical analysis of the literature included for systematic review suggests that there is a significantly higher risk of developing AT in patients that have concomitant HLD, HTN, and TDs. Curiously, the statistical analysis for the data regarding patients with AT and DM showed that DM can actually be protective against the development of AT. This unexpected result of the statistical analysis may be due to the high risk of bias in the studies included and will certainly require further review of the literature.

ABSTRACTS

VTE Prophylaxis and Hormonal Contraceptive Use during the Perioperative Period for Anterior Cruciate Ligament Reconstruction: A Survey of the AANA Membership

Christian RA, Lander ST, Bonazza NA, Reinke EK, Lentz TA, Dodds JA, Mulcahey MK, Ford AC, Wittstein JR

Background: Venous thromboembolism (VTE) is a rare, but potentially serious complication after anterior cruciate ligament reconstruction (ACLR). Though evidence has not supported routine use of chemoprophylaxis post-operatively, there are no clear guidelines for treatment of higher risk individuals, such as patients using hormonal contraceptives.

Purpose/Hypothesis: The purpose of this study was to evaluate the VTE prophylaxis practices of surgeons performing ACLR in female patients using hormonal contraceptives. Our hypothesis was that there is not a standard of care among orthopaedic sports medicine surgeons, but many surgeons change their practice based on prior clinical experience with VTE after ACLR and identification of hormonal contraceptive use as VTE risk. A secondary hypothesis was that female surgeons are more likely to ask about and modify treatment plans due to hormonal contraceptives.

Study Design: Cross-sectional study; survey-based.

Methods: An investigational survey utilizing branching logic was created by our research team and approved for distribution by the Arthroscopy Association of North America's (AANA) Research Committee. The survey was then distributed to the AANA membership for response. The survey was designed to identify the respondent's clinical decision-making regarding the use of VTE prophylaxis following ACLR in patients without risk factors for VTE, their counseling to patients about the risk of VTE associated with hormonal contraceptive use during the perioperative period, and their use of VTE prophylaxis following ACLR in patients taking hormonal contraceptives.

Results: 94 respondents completed the survey, all of whom perform ACLR. 89 respondents identified their gender to be 62.9% male (56) and 37.1% female (33). Respondents report performing the following number of ACLRs annually: >50 (38, 40.4%), 30-50 (27, 28.7%), 15-30 (27, 28.7%), and <15 (2, 2.1%); 66.7% (62) of respondents routinely use pharmacologic VTE prophylaxis post-operatively for patients after ACLR. 62 respondents (66.7%) reported having a patient develop VTE after ACLR. Of these respondents, 20 (32.3%) had a male patient with VTE, 15 (24.2%) had a female patient with VTE, and 21 had both male and female patients with VTE after ACLR. 66.7% of respondents use pharmacologic prophylaxis for their patients after ACLR. Female surgeons were more likely to ask about hormonal contraceptive use ($p = 0.01$; OR 4.2). Female surgeons were also more likely to change their VTE prophylaxis plan as a result of asking about hormonal contraceptive use ($p = 0.02$; OR 2.8). Surgeons that have had a female patient with VTE after ACLR were more likely to ask about hormonal contraceptive use ($p = 0.03$; OR 2.9). Surgeons that have had a female patient with VTE after ACLR were also more likely to change their VTE prophylaxis plan as a result of asking about hormonal contraceptive use ($p = 0.001$; OR 4.6).

Conclusion: There is no standard of care for VTE prophylaxis after ACLR. A surgeon's own gender and prior clinical experience with VTE after ACLR may influence their likelihood to consider a patient's hormonal contraceptive use with regard to VTE risk after ACLR.

ABSTRACTS

Two-Year Non-Modifiable and Modifiable Predictors of Six-Year Function Following Primary Anterior Cruciate Ligament Reconstruction

Lukes DH, Pietrosimone LS, Lentz T, Reinke EK, MOON Group

Background/Purpose: Previous research has investigated clinical factors associated with self-reported function and return to sport following anterior cruciate ligament reconstruction (ACLR). Associations between self-reported outcomes and knee pain at six-year post ACLR have been reported. However, predictive models including clinical, performance, and self-reported data have not been evaluated for later time points following ACLR. Determining the predictive nature of non-modifiable and modifiable factors on long-term knee function may provide opportunities for individualized interventions to improve quality of life and reduce deleterious effects of ACLR on joint health. Therefore, the purpose of this study was to examine two-year non-modifiable and modifiable predictors of six-year self-reported function following ACLR. We hypothesized that IKDC but not hop testing at two years would predict six-year self-reported function.

Study Design: Prospective cohort study; Level of evidence, II

Methods: This analysis utilized a nested cohort from the Multicenter Orthopedic Outcomes Network (MOON) prospective cohort who had surgery from 2005-2012. Inclusion criteria included were less than age at two-year follow-up, primary ACLR with autograft, injured playing sport, no history of concomitant ligament surgery, ACL revision surgery, or contralateral knee surgery. Exclusion criteria included individuals who were pregnant or had previous ACL rupture on either limb. Patients who had complete data at two and six years post-ACLR were included. Descriptive statistics were run for dependent and all predictor variables. Hierarchical, stepwise linear regression models were evaluated with six-year IKDC score as the dependent variable in two blocks. The first block included non-modifiable variables: geographic surgery location, age, graft type (2 levels: bone-patellar tendon-bone (BTB), soft tissue), meniscal procedure (4 levels: normal, no treatment/abrade/trephine, excision, repair; medial and lateral separately), chondral defect (2 levels: yes/no; medial and lateral compartments separately), and sex (2 levels: male, female). The second block utilized a backwards selection approach, controlling for all non-modifiable factors from the first block, and added the following modifiable variables: single leg hop for distance (SLH) limb symmetry index (LSI), triple hop for distance (THD) LSI, smoking status (3 levels: never smoke, former smoker, current smoker), BMI, Marx Activity Scale score, and IKDC score. A secondary exploratory analysis using a sub-sample of patients completing the ACL-Return to Sport Index (ACL-RSI) at two-year post-ACLR was completed using the same aforementioned variables to determine if this ACL-specific patient-reported outcome adds to the primary model. Statistical significance was set a priori at alpha <0.05 for all analyses.

Results: For the primary analysis, 309 patients (54.7% female, age: 22.23±4.82 yrs, BMI: 25.12±3.96 kg/m²) were included. In the final overall model, predictors of lower six-year IKDC score included: female sex, presence of a medial compartment chondral defect, lower two-year IKDC, and higher BMI. When controlling for all non-modifiable variables, 2-year IKDC was the strongest modifiable predictor of six-year IKDC. (R² change=0.199, p<0.001). The addition of two-year BMI resulted in a small improvement in prediction (R² change=0.010, p=0.038). No other modifiable variables demonstrated statistical significance. Secondary analysis (n=84) demonstrated that when added to the original model, two-year ACL-RSI score explained an additional ~20% of the variance in six-year IKDC (R² change=0.20, p<0.001) and was a stronger predictor than two-year IKDC score.

ABSTRACTS

Two-Year Non-Modifiable and Modifiable Predictors of Six-Year Function Following Primary Anterior Cruciate Ligament Reconstruction

Lukes DH, Pietrosimone LS, Lentz T, Reinke EK, MOON Group (Continued)

Conclusion: A combination of modifiable and non-modifiable variables two years post ACLR predicted self-reported function at six-year follow-up. Specifically, female sex, medial compartment chondral defect, high BMI, and low IKDC accounted for approximately 26% of the variance in IKDC score at six-years. Of all modifiable variables, IKDC at two years accounted for the most variance in the overall model. Additionally, in a sub-sample analysis, two-year ACL-RSI score accounted for approximately 20% of the variance beyond all other modifiable factors. Interestingly, two-year single and triple hop test LSIs do not appear to contribute to estimations of six-year self-reported function following ACLR.

Clinical Relevance: Results from this study add to the current body of research by identifying factors that influence long-term self-reported function post-ACLR. Given the high rates of poor function and accelerated progression to post-traumatic osteoarthritis (PTOA) following ACLR, serially assessment of modifiable factors may provide opportunities for targeted, individualized interventions to improve long term outcomes. Of note, hop testing LSIs at two years were nearly symmetrical on average (mean (SD) SLH: 98.0±0.13% and THD: 97.0±0.08%, respectively). The low variation in LSI at two years in this sample suggests these common performance tests may be more clinically useful at earlier time points post-ACLR (i.e. to inform return to sport decision making) when more variability exists. ACL-RSI, which evaluates the constructs of emotions, risk appraisal, and confidence in performance, appears to be a strong predictor of IKDC at six years post-ACLR. Although the cohort for this sub analysis was small, these preliminary results suggest ACL-RSI may provide useful information on future disability following ACLR, even than two-year IKDC score can provide. Future research should consider these results when developing patient-centered rehabilitation strategies to promote long-term function and joint health following ACLR.

The Association between Orthostatic Vital Signs and Return-to-Play after Concussion

Ferry B, Reinke EK, Ceraulo A, Green C, Poehlein E, Martinez C, Bytowski JR

Purpose: Identify whether patients with evidence of dysautonomia after concussion, identified by positive orthostatic vital signs, documented exercise intolerance, or a new diagnosis of dysautonomia/POTS have a prolonged return-to-play after injury.

Introduction: Dysautonomia is an increasingly recognized sequela after concussion. Over 70% of a cohort of adolescent athletes with persistent post-concussion symptoms were found to have a positive table tilt test, which is a marker for dysautonomia and orthostatic intolerance. Measurement of orthostatic vital signs is a more feasible measure of assessing for dysautonomia during a post-concussion assessment. Additionally, exercise intolerance after concussion is suspected to be related to underlying autonomic dysfunction. Less commonly, patients have been newly diagnosed with chronic autonomic dysfunction following concussion. This retrospective cohort study seeks to identify whether positive orthostatic vital signs, exercise intolerance, or a new diagnosis of dysautonomia are associated with prolonged return-to-play after an athletics-related concussion.

Methods and Study Design: A retrospective, cohort investigation evaluated patients aged 13-25 who sustained a sports-related concussion and presented to the Sports Medicine Concussion Clinic at Duke University between January 2015 and December 2019. Patients with non-sports related concussions, without return-to-play dates, without recorded orthostatic vital signs, and those lost to follow-up were excluded from the study. Primary outcomes include a composite marker for underlying autonomic dysfunction that included positive orthostatic vital signs (systolic BP decrease of greater than or equal to 20, diastolic greater than or equal to 10, or heart increase greater than 20 beats per minutes at 1 or 3 minutes after moving from supine to standing), documented exercise intolerance, or new diagnosis of dysautonomia and time to return-to-play.

Results: 143 patients met initial inclusion criteria for the study. This included 69 male patients (48.3%) and 74 female patients (51.7%). Mean age of the patients was 15.92 years. Soccer (28.7%), basketball (20.3%), and football (14%) were the most commonly represented sports. 32.2% of patients had suffered a prior concussion, and 33.6% of patients had a prior diagnosis of underlying psychiatric condition. Median time from injury to initial evaluation was 6 days, and median time from injury to return-to-play was 30 days. 71 patients met criteria for positive orthostatic vital signs, 16 patients were noted to have exercise intolerance, and one patient was newly diagnosed with dysautonomia. Specific statistical analysis comparing return-to-play times is pending at the time of abstract submission.

Conclusions: In a representative patient population, abnormalities in orthostatic vital signs were identified in nearly half of patients. Current data about the prevalence of dysautonomia after sports-related concussion, and this measure provides an initial measure of frequency in this specific population. Conclusions about the impact of findings on return-to-play pending further statistical analysis.

The Impact of COVID-19 on Injury Rates among Collegiate Athletes

Rugg CM, Kirsch AN, Katsuta Y, Beatty K, Lau BC, Pietrosimone LS

Background: Collegiate athletes experienced changes to their training resources and routines as a result of the SARS-COV2 (COVID-19) pandemic during the stay-at-home period. The purpose of this study is to determine the impact of COVID-19 on injury rates in collegiate football and swimming/diving (S/D) athletes in the 90 days following return to collegiate sports in 2020 compared to the prior three years. We hypothesize that injury rates in collegiate athletes in 2020 will be elevated compared to prior seasons in the 90-day return to play period.

Methods: Collegiate athletes from a single institution who were listed on the roster for football or S/D from the 2017-2018 season to the 2020-2021 season were included in the study. Injury data were collected for each season using Presagia injury management system (Football) or athletic trainer electronic records (S/D). The data extracted included date of the injury and the body part affected, which were categorized as lower extremity, upper extremity, spine/torso, head, and heat-related illness. Date of initiation of sport participation was identified for each sport and for each season (preseason day 1). Injuries occurring within 90 days of initiation of sport participation were coded as "events" and included for analysis. Kaplan Meier survival curves were calculated for time-to-first injury for each year, and rates of all injuries over each 30 day segment (days 0-30, day 31-60, day 61-90) were calculated.

Level of Evidence: Cohort Study, Level III

Results: A total of 633 athletes participated in football (n=424) or S/D (n=209) in the 2017-2020 seasons and were equally distributed between the four seasons. During the 90-day period following initiation of sport participation, the percentage of athletes injured per season ranged from 52.5%-64.5% in 2017-2019 and was lower in 2020 (49.0%, p=0.012). Football athletes had injury rates over 70% in both 2017 and 2019, and rates between 62 and 63% in 2018 and 2020 (P=.213). S/D athletes had the lowest rate of injury in 2020 (25%), with a range of 32.0% to 51.1% in the 2017-2019 seasons (p=0.033). Two Kaplan-Meier log rank test procedures were run to determine if there were differences in the survival distribution for first-time injury for the different years (2017-2020) for all athletes and for each separate team, respectively. The survival distributions for the four years for all teams demonstrated statistically significant differences (chi-squared (3) = 13.462, p<0.005). The survival distributions for the four years demonstrated statistically significant differences for S/D (chi-squared (3)= 9.061, p<0.05), but there were no statistically significant differences for football (p=0.078). When examining injury rates in 30-day increments, there were only statistically significant differences between 30/60/90-day injury rates for S/D (p<0.005) but not football (p=0.058).

Conclusions: Contrary to our hypothesis, athletes returning to play following the COVID-19 stay-at-home period suffered fewer injuries in the first 90 days after initiation of sport participation. It is plausible that more balanced training recovery and rest leading up to return to formal on-campus sport participation, attention to load management, and a heightened focus on injury prevention led to fewer injuries in collegiate athletes prior to the 2020-2021 season. These strategies warrant further study to determine if their application to future athletes may reduce early season injury rates at the collegiate level.

Sink or swim? Clinical measures associated with pain and injury in swimmers: A systematic review

Otley TJ, Tate A, Myers H, Hendren S, Kennedy J

Purpose: Shoulder injuries are the most common complaint among swimmers ranging from 40-91% of swimming injuries and can result in time loss from training and competition, ultimately leading to decreased performance. Clinical examination of the swimmer's shoulder typically includes multiple musculoskeletal factors in determining related impairments. The primary purpose of this study is to investigate objective measures utilized to assess swimmers and to assess the relationship of abnormal test values to shoulder pain and injury in distinct age group/competition levels. A secondary aim to establish normative/expected values for these tests.

Methods: Databases including Medline (via OVID), Embase, CINAHL Complete, SPORTDiscus, and Scopus were searched from inception to November 2020. Studies were identified for screening if they assessed an objective measure(s) and shoulder pain and/or injury in age-group, collegiate, or elite level swimmers. A Systematic Review was conducted utilizing Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines employing 2 reviewers at each phase of the process (title/abstract review, full text review, and data extraction) and a third reviewer for conflict resolution. A risk of bias assessment for all articles included in this systematic review was performed independently by 2 reviewers using the Methodological Items for Non-Randomized Studies (MINORS) assessment tool. The level of evidence was ranked for each study using the Oxford Center of Evidence Based Medicine (OCEBM) guidelines. Disagreements for risk of bias and level of evidence were resolved by consensus. Objective measures, age/competition level of swimmers, and the relationship between objective measures and pain/injury was extracted for included studies. Clinical implications were evaluated qualitatively.

Results: Twenty-two studies were included in this systematic review (Level I: 0; Level II: 4; Level III: 14, Level IV: 4). The level of agreeability of the risk of bias between the two reviewers was calculated with a correlation coefficient ($r = 0.80$). Moderate/strong level of evidence supported a relation to shoulder pain/injury for increased laxity and lower values for horizontal adduction (HA) and internal rotation (IR) range of motion, middle trap strength, pectoralis minor and latissimus dorsi extensibility, and side bridge core endurance. Low level evidence supported a relationship between shoulder pain/injury and external rotation (ER) to IR strength ratios less than 0.68. Meta-analysis was not performed due to heterogenous data collection techniques.

Conclusions: Clinical examination of the swimmer's shoulder should include the following objective clinical tests: 1. rotator cuff external rotation and internal rotation strength with the development of ER:IR ratios at 90 degrees of abduction, 2. periscapular strength and scapular upward rotation excursion, 3. lateral core stability, 4. shoulder HA, ER and IR range of motion, 5. pectoralis minor and latissimus dorsi extensibility, and 6. assessment of glenohumeral laxity. There was insufficient data to determine normative values for these objective tests at varied age/competition levels.

Clinical Relevance: This systematic review provides clinicians with an evidence-based array of objective clinical tests for evaluating swimmers at risk for shoulder pain and injury. Prospective collection of standardized objective tests and measures for varied age/competition levels with tracking of shoulder injuries in swimmers can assist in developing cutoff values to predict injury risk.

ABSTRACTS

COVID effects your lungs, blood, politics, and even training room

Friedman E, Reinke EK, Ceraulo A

Purpose: This study was performed to find out if there is a significant difference in the number and types of training room visits before COVID started and after COVID.

Introduction: There are about 500,000 student-athletes that compete in 24 different sports every year. COVID has greatly affected volumes in all aspects of health care. ED visits declined approximately 42% during the COVID pandemic in the USA with volumes going from an average of 2.1 million visits per week in 3/31/2019-4/27/2019 to only an average of 1.2 million visits per week from 3/29/2020-4/25/2020. A higher percentage of those visits were related to infectious disease. There is no study currently evaluating how athlete training room visits at a University has been affected by COVID.

Methods and Study Design: For this study, a retrospective review of Duke training room visits was performed. The training room data from July-January from the five years before COVID-19 and this year after COVID-19 were collected. Data including athlete sex, sport, and encounter diagnosis were collected and compared. Athlete diagnoses were grouped into larger diagnostic categories and were analyzed.

Results: A total of 1008 university athletes were evaluated during 2728 medical encounters. Total number of training room visits were decreased significantly from an average of 502 per year to 219 in 2020-2021. The number of ENT complaints, which included upper respiratory infections (URIs), acute sinusitis, pharyngitis was the most decreased from an average of 178 average diagnoses annually to 26. Track and field was the sport that decreased the most from 66 average annual encounters to 11 encounters.

Conclusions: The COVID pandemic has affected hospital volumes greatly which has caused hospitals to change staffing and other functions to adapt. Training room was also greatly affected by the COVID pandemic. This study may be useful in the future for determining staffing and other expectations of what to expect in training room since the COVID pandemic and can help best direct care for NCAA athletes.

The Path to Perfection: A Systematic Review of Learning Curves in Sports Surgery

Shultz CL, Levine N, Christian RA, Hendren S, Mather RC, Lassiter TE, Green CL, Lau BC

Background: Every patient encounter is a data point on a surgeon's learning curve. As young surgeons enter into practice, or as senior surgeons embark on new procedures, we are tasked with making an ethical and pragmatic assessment of our own abilities and weighing the potential risks to our patients.

Purpose: The aim of this article is to review basic concepts in adult learning theory as they pertain to surgical principles, review the current knowledge of learning curves by surgical procedure, and discuss the implications for education, training, and patient safety.

Study Design: Systematic Review

Methods: Pubmed-MEDLINE, Scopus, and Embase databases were queried for "Learning Curves" pertaining to surgical procedures in orthopaedics according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. Abstracts were reviewed by 2 independent reviewers (C.S., N.L.) for inclusion into the review and further subdivided into general categories including: Shoulder Arthroscopy and Reconstruction, Shoulder Arthroplasty, Hip Arthroscopy and Osteotomy, Knee Arthroscopy and Reconstruction, and Knee Osteotomy.

Results: 4,558 articles were reviewed for inclusion. 14 articles for shoulder arthroscopy and reconstructive procedures, 10 articles for shoulder arthroplasty, 17 articles for hip arthroscopy, 5 articles for hip osteotomy, 7 articles for knee arthroscopy and reconstructive procedures, and 2 articles for knee osteotomy. The net defined learning curve for each respective surgical sub-category was 22 for shoulder arthroscopy and reconstruction, 28 for shoulder arthroplasty, 71 for hip arthroscopy, 19 for hip osteotomy, 28 for knee arthroscopy and reconstruction, and 32 for knee osteotomy.

Conclusion: Surgeons should consider the synthesis of the described learning curves for shoulder, hip, and knee surgery when incorporating these procedures into their practice. Learning curves exist for multiple surgical outcomes including operative time, complications, implant position, PROM's, and revision surgery rates.

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