2018 CASEM Poster Presentations

Examining Knee Control as a Risk Factor for Non-contact Lower Extremity Injury: A Prospective Study in Youth Soccer

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Objective: To examine the association between the frontal plane knee projection angle (FPKPA) during the single-leg squat and acute non-contact lower extremity injury.
Study Design: Youth soccer players, 10 to 14 years, participated in a baseline single-leg squat and a 20-week injury registration. Acute non-contact lower extremity injuries were registered by weekly text messaging. In case of an injury, the study physiotherapists contacted the injured player and/or parent to collect details of the injury by standardized phone interview.
Subjects: Five hundred seventy youth soccer players (454 boys, 116 girls).
Observation Technique: The single-leg trials were recorded by a high definition video camera. The FPKPA was estimated using a 2-dimensional video analysis. The mean FPKPA for right and left leg separately was calculated from a minimum of 2 valid single-leg squat performances.
Outcome Measures: The outcome measure was acute non-contact soccer training or match play injury to hip, groin, thigh, shin, calf, ankle or foot that caused the need for medical attention or time loss from soccer activities. Non-contact injuries were defined as injuries that resulted without direct contact to the injured body part.
Results: During the follow-up, 145 non-contact lower extremity injuries were registered. The FPKPA was not associated with acute non-contact lower extremity injuries.
Conclusions: In conclusion, frontal plane knee control is not associated with injuries among 10 to 14-year-old soccer players.
Acknowledgments: The authors would like to thank the athletes and their parents and coaches of the participating teams for their excellent cooperation.

A Machine Learning Approach to Predicting Running-Related Pain Using Wearable Technology

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Objective: To predict the onset of running-related pain based on deviations from an individual's typical biomechanical running pattern.
Study Design: Case Study.
Subjects: One female runner (32 years, 1.70 m, 70.3 kg), 10-year history of running, recent half marathon time 2:03, beginning a half marathon training program with average weekly mileage 12 km/wk.
Observation Technique: On 3 consecutive Sundays, the runner completed identical 7.5-km runs on a paved running path as part of her normal training program. An inertial measurement unit (IMU) containing a tri-axial accelerometer and gyroscope (100 Hz) was positioned on the lower back near the centre of mass.
Outcome Measures: The outcome measures from the IMU were cadence (steps/min), vertical oscillation (m), braking (m/s), pelvic rotation (deg), pelvic drop (deg), and ground contact time (ms), measured every 10 steps throughout the run. A Visual Analog Score (10 cm scale) was used to subjectively rate level of pain after each run. A model of her "typical" biomechanical running pattern was created using a one-class support vector machine trained using the IMU data from the first pain-free run. The model was applied to the remaining 2 runs to determine the percent of anomalous strides in each run, and the rate of anomalous strides throughout each run.
Results: The runner reported no pain during the first and third runs, but experienced pain in the left quadriceps (1 cm) after 20 minutes during the second run. The percent of anomalous strides from the second and third runs was 70.82% and 2.75%, respectively. The rate of anomalous strides throughout the third (pain-free) run was similar to the rate of anomalous strides in the first 5 minutes of the second run (with pain). However, the rate of anomalous strides increased to over 50% after the first 5 minutes of the second run, prior to the onset of pain.
Conclusions: The amount and rate of anomalous strides based on a subject-specific model of running patterns could be used to predict pain during a training run.
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Evaluating the Effectiveness of a Ski and Snowboard Injury Prevention Video on Safety Knowledge in Children and Adolescents

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Objective: To evaluate the effect of a ski and snowboard injury prevention video on child and adolescent safety knowledge.
Study Design: Cluster randomized controlled trial.
Subjects: Students in grades 2 to 9 who were part of a ski/snowboard school program hosted at a ski area in Southern Alberta (n = 1034).
Intervention: Schools were block randomized into control or intervention groups. The control group followed the existing protocol for school programs, including an orientation video. The intervention group followed the same protocol, but received a different video that focused on ski-snowboard safety based on expert opinion, current literature and focus group research.
Outcome Measures: Students took a 15-question baseline test about safety before (pre) and after (post) watching their assigned video. The within-subject difference between the pre- and post-test scores was calculated for all students. A follow-up post-test was administered 1 month after viewing the video and compared with the initial post-test to assess retention. Linear regression was used to assess mean change scores and 95% confidence intervals (CI) by group while adjusting for class-level clustering.
Results: The mean pre-test scores were 11.62 for the control group (95% CI: 11.48-11.76) and 11.82 for the intervention group (95% CI: 11.63-12.01). Intervention group knowledge increased (mean post-test score: 13.73, 95% CI: 13.58-13.88; mean change: +1.91 points) with no change in control group knowledge (mean post-test score: 11.72, 95% CI: 11.57-11.88; mean change: +0.10 points). The follow-up was completed by 251 participants. The mean follow-up change score was 0.60 for the control group (mean follow-up score: 12.71, 95% CI: 12.49-12.92) and no evidence of a change in the intervention group (mean follow-up score: 13.90, 95% CI: 13.61-14.19).
Conclusions: Results show that a ski-snowboard safety video can increase knowledge within a school-aged population with some evidence this information can be retained after 1 month.
Acknowledgments: The Sport Injury Prevention Research Centre is an International Research Centre for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee. This project was funded by an Alberta Innovates Collaborative Research and Innovation Opportunities program grant. We thank the students, parents, and teachers for their participation.

The Effectiveness of a Gait Retraining Program to Reduce Peak Braking Force in Recreational Runners

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Objective: To determine the effectiveness of a real-time biofeedback gait retraining program on reducing peak braking force (PBF) in recreational runners.
Study Design: Prospective, interventional repeated measures design.
Participants: Sixteen healthy novice female recreational runners aged 18 to 60 with high PBF.
Intervention: Participants followed a 15-week half-marathon training program with 8 lab-based gait retraining sessions, during which participants were provided with real-time visual biofeedback of braking forces and asked to keep the PBF below a target threshold on the monitor. Feedback and running time were increased throughout the first 4 sessions before feedback was reduced for the final 4 sessions to facilitate learning.
Outcome Measures: The primary outcome measure was peak braking force. Secondary outcome measures included horizontal distance from heel to centre of mass (HCOM), step length (SL), step frequency (SF), foot strike index (FSI), hip flexion angle at initial contact (HFIC), and vertical displacement of centre of mass (VDCOM). Outcome measures were assessed at baseline and follow-up. At follow-up, participants were asked to run with a natural gait (NAT) and then with their new modified gait pattern (MOD). A repeated measures ANOVA with 95% confidence intervals assessed change in all outcomes from baseline to NAT and MOD.
Results: Twelve participants completed the 15-week training program. A repeated measures ANOVA determined that mean PBF differed significantly from baseline to follow-up testing ($P = 0.001$). Post hoc tests using the Bonferroni correction revealed that the gait retraining intervention elicited a statistically significant reduction in PBF from baseline to follow-up when the participant was asked to run naturally (0.333 ± 0.050 BW vs 0.274 ± 0.027 BW; $P = 0.008$) and with the modified gait pattern (0.265 ± 0.026 BW; $P = 0.002$). Kinematic outcome measures that relate to overstriding (HCOM, SL, and HFIC) also showed reductions from baseline to follow-up testing.
Conclusions: A 15-week, 8-session faded-feedback real-time gait retraining intervention elicited a statistically significant reduction in PBF among female recreational runners. Kinematic outcomes suggest that cues that decrease overstriding may assist in retraining runners to reduce PBF in a clinic setting.
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Findings from First Adaptation of Competency-Based Assessment System (CBAS) in 2 Canadian Sport and Exercise Medicine (SEM) Enhanced Skills Residency Programs

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Objective: In Canada, competency-based assessment is mandatory for Category 1 Enhanced Skills (ES) residency programs, where a Certificate of Added Competence (CAC) is awarded through the College of Family Physicians of Canada (CFPC). From 2013 to 2016, the Competency-Based Achievement System (CBAS), developed and validated for Family Medicine residents at the University of Alberta, was piloted in 2 Canadian university-based Sport and Exercise Medicine (SEM) programs. Timely formative feedback and observations (FieldNotes) regarding competencies contribute to cumulative evidence of progress and inform summative assessment.
Study Design: Mixed methods prospective cohort study.
Subjects: Preceptors (n = 26), Residents (n = 14), Support Staff (n = 2), Program Directors (n = 2).
Intervention/Observation Technique: Quantitative: Paper-based versus electronic FieldNotes. Qualitative: Focus groups/semi-structured interviews.
Outcome Measures: Number/range of FieldNotes; barriers and enablers of FieldNotes in SEM.
Results: Findings indicate that site A (electronic system) consistently recorded more FieldNotes/resident/month than did site B (paper-based) (overall mean site A = 10.3; site B = 6.6). For both Sites, FieldNotes were representative across all SEM competencies/clinical domains. FieldNotes were particularly valuable in tracking progress in the case of a resident who encountered difficulty (18.9 FieldNotes/mo recorded). Qualitative findings indicate that FieldNotes are a valuable tool to provide timely feedback that accurately tracks achievement of competencies in an efficient and effective manner. Specifically, cumulative FieldNotes provided a clear picture of resident progress to produce an accurate summative assessment. The majority of preceptors found they were able to provide more feedback using CBAS; this may have contributed to resident learning. Barriers to using CBAS were often related to mode of delivery (paper-based vs electronic). While a majority of preceptors preferred electronic FieldNotes, many reported areas for improvement, such as simplified log-in procedures. In addition, preceptors report requiring a more effective reminder system to complete FieldNotes, perhaps built into CBAS. Uptake/transition also improved when former residents trained in CBAS were integrated as new preceptors.
Conclusions: Uptake of SEM CBAS increased over time, with greater documentation of progress using FieldNotes. CBAS supported detailed feedback on resident progress, including early identification of residents in difficulty. Modifications of SEM CBAS continue, particularly delivery format (paper-based vs electronic).
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The Evaluation of a Risky Behaviour Assessment Tool in Child Skiers and Snowboarders

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Objective: To assess the accuracy and reliability of a Risky Behaviour and Actions Assessment Tool (RBAAT) among young skiers and snowboarders.
Subjects: Students in grades 2 to 6 who participated in a ski and snowboard school program hosted at a local ski area in Southern Alberta.
Observation: The RBAAT contains a checklist of known risky behaviours in snow-sports based on literature, personal communication with ski/snowboard patrollers, and the Alpine Responsibility Code. Video footage was collected for 90 minutes in the beginner area on 4 different days. A snowboard instructor created and rated 100, 15 seconds video clips, deeming 35 to contain risky behaviours. A ski patroller and former ski instructor also independently rated each video clip using the RBAAT and came to a consensus with the snowboard instructor. In addition, a non-expert research assistant (RA) completed the RBAAT for each video clip and his/her ratings were compared with the consensus. Two RAs also observed skiers and snowboarders on the ski hill and recorded behaviours using the RBAAT (n = 227).
Outcome Measurements: For the video clips, percent agreement and Kappa (K) coefficients with 95% CI were calculated comparing the non-expert ratings to the consensus, along with sensitivity, specificity, and negative (NPV) and positive predictive values (PPV). For on-hill observations, percent agreement and K with 95% confidence intervals (CI) were calculated between the 2 observers.
Results: When comparing the non-expert RA ratings to the consensus for any risky behaviour, there was 91% agreement (K: 0.79; 95% CI: 0.66-0.92), 81.25% sensitivity and 95.58% specificity. The PPV was 89.66% and the NPV was 91.55%. There was 91.63% agreement for any risky behaviour between the 2 observers (K: 0.78; 95% CI: 0.68-0.87).
Conclusions: Results suggest that the RBAAT is accurate and reliable for assessing risky ski and snowboard behaviours among beginners.
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Evaluating the Effectiveness of a Ski and Snowboard Injury Prevention Video on Risky Behaviours and Injury in Beginner Children

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Objective: To evaluate the effect of a ski and snowboard injury prevention video on rates of risky behaviours and injury among children.
Study Design: Cluster randomized controlled trial.
Subjects: Students from 18 schools in grades 2 to 6 who were part of a ski/snowboard school program hosted at a local ski area in Southern Alberta.
Intervention: Schools were block randomized into either a control or intervention group. The control group followed the existing procedures for school programs, including an orientation video. The intervention group followed the same protocol but received a different video that focused on ski-snowboard safety based on expert opinion, current literature and focus group research.
Outcome Measures: To assess risky behaviour, blinded research assistants (RA) observed and recorded the characteristics and behaviours of participants in the beginner area during lessons. There were 27 days where one RA observed and collected data on risky behaviours. Injury data came from ski patrol Accident Report Forms (ARF). Denominator data on the total number of students and outings came from school program enrollment forms. Unadjusted incidence rates of risky behaviours and injuries were calculated by intervention status.
Results: Ten schools were assigned to the control group and 8 to the intervention group. There were 407 on-hill observations completed with 38 risky behaviours seen in 163 person-runs in the control group (23.31/100 person-runs) and 56 risky behaviours in 244 person-runs (22.95/100 person-runs) in the intervention group. There were 10 injuries in 2876 person-outings (3.5/1000 person-outings) for the control group and 19 injuries in 2028 person-outings (9.4/1000 person-outings) for the intervention group.
Conclusions: Rates of risky behaviours were similar in intervention and control groups. Further analysis is required to examine and account for the covariate profiles as well as the circumstances and mechanisms of injury by intervention status.
Acknowledgments: The Sport Injury Prevention Research Centre is an International Research Centre for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee. This project was funded by an Alberta Innovates Collaborative Research and Innovation Opportunities program grant. We thank the students, parents, and teachers for their participation in this study.

The Role of Sleep Habits and Caffeine Consumption on the Risk of Sport Injury in Adolescent Ice Hockey Players

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Objective: To examine the association between sleep habits and caffeine consumption and the risk of injury in adolescent ice hockey players.
Study Design: Nested case–control study.
Subjects: Preliminary data were collected from 138 players, including 42 concussed, 27 musculoskeletal (MSK) cases, and 68 controls. Study participants were recruited from a larger longitudinal cohort study "Safe2Play." Participants included Pee Wee, Bantam, and Midget (11-17 years) ice hockey players in Calgary.
Observational Technique: Participants were asked to complete 2 validated questionnaires regarding their regular consumption habits of caffeine on the day of injury and their typical sleep patterns the 7 nights before the day of injury (MSK or concussion). A matched uninjured control group was also selected to complete the same questionnaires.
Outcome Measures: Three independent groups included concussion, MSK injury, and an uninjured control (matched for sex, age, and level of play). Injury surveillance methodology previously validated in youth ice hockey was used to identify cases who sustained a suspected concussion or MSK injury during a hockey related practice or game. Controls were uninjured players randomly selected to complete both questionnaires.
Results: Preliminary data indicates that 5 of 42 (11.9%) players sustaining a concussion, and 4 of 27 (14.8%) players suffering a MSK injury reported caffeine consumption within 6 hours before the start of their on-ice practice or game. Four of 42 (9.5%) players from the concussion group, and 2 of 27 (7.4%) players from the MSK group reported a lack of sleep in the week leading up to injury.
Conclusions: The findings of this research can inform injury prevention strategies in youth ice hockey regarding sleep habits and caffeine consumption before practices and games. A better understanding of all potential risk factors associated with injury, can inform optimal injury prevention and athlete care.
Acknowledgments: The Sport Injury Prevention Research Centre is one of the International Research Centres for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee. We acknowledge the funding from Canadian Institutes of Health Research, Alberta Innovates Health Solutions, Hotchkiss Brain Institute, and Alberta Children's Hospital Foundation. We would like to acknowledge Hockey Canada, Hockey

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Urinary Incontinence Among Competitive Female Rope Skipping Athletes

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Objective: To determine the prevalence,impact and management of urinary incontinence (UI) among Rope Skipping (RS) athletes.
Study Design: Cross-sectional observational study.
Subjects: Competitive female RS athletes ages ≥13 years, attending the 2017 Rope Skipping Canada national championships (Kingston, ON, Canada).
Intervention/Observation Technique: All eligible athletes received a questionnaire in their registration packages that was collected throughout the competition.
Outcome Measures: The overall prevalence of UI during RS was determined by a simple question. An unvalidated sport-specific questionnaire inspired by the IIQ-7 was used to assess the prevalence and bothersomeness of UI for each RS event type. Data was collected on UI management while RS, extent of interference from UI with RS participation and quality-of-life (ICIQ-SF).
Results: One hundred sixty-two athletes were approached; 89 surveys were completed (55%). Results are reported as median (IQR). The median age was 16 years (14-19.5), BMI of 21 kg/m^2 (19.5-22.9); and subjects practiced RS 360 min/wk (240-360), were menarchal (88%), and nulliparous (93%). Seventy-five percent of athletes reported UI during RS. Among those incontinent during RS, 21% (14/67) indicated that the overall impact of UI on RS was moderate or greater (score of ≥4; scale from 1 to 10 on the sport-specific questionnaire). Median ICIQ-SF score in incontinent athletes was 4.0 (3.0-6.0). Consecutive "double unders" and "triple unders" were associated with the greatest prevalence of UI during competition, 67% (36/54) and 86% (48/56) of participants, respectively. Attrition from participation in either of these 2 events due to UI was 6% (4/67) in competition and 16% (11/67) in practice. Athletes managed their UI with containment products (38%), by limiting fluid intake (20%) or by voiding before (72%), or between RS events (71%). Despite the significant impact of UI on some athletes, none were treated for it. Menstruating athletes were 8 times more likely to have UI than premenarchal athletes (95% CI 1.5-56).
Conclusions: Similar to other high-impact sports, female RS athletes experience a very high rate of UI while participating in RS, which can lead to sport attrition. This research will help guide UI awareness, prevention, and management strategies for RS athletes, coaches, parents and organizations.

Validation of a Self-Report Measure of Patellar Tendinopathy: Analysis of an Adapted Ostrc Overuse Injury Questionnaire and Clinical Evaluation in Youth Basketball

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Objective: To evaluate the diagnostic accuracy of an adapted Oslo Sports Research Trauma Centre (OSTRC) Questionnaire–the OSTRC patellar tendinopathy (OSTRC-P) Questionnaire–in detecting patellar tendinopathy in youth basketball players when compared to clinical evaluation by a physiotherapist.
Study Design: Prospective diagnostic accuracy validation study.
Subjects: In total, 208 players (aged 13-18 years) were recruited during an in-season period of high school and club basketball in Alberta, Canada.
Intervention: Following the Standards for Reporting of Diagnostic Accuracy Studies guidelines and within a given week, participants completed the OSTRC-P Questionnaire (index test) prior to a clinical evaluation (reference standard) by a physiotherapist blinded to OSTRC-P Questionnaire results.
Outcome Measurements: Sensitivity, specificity, predictive values (PVs), likelihood ratios (LRs) and post-test probabilities were calculated. Additionally, age-specific sensitivity and specificity of the OSTRC-P Questionnaire were explored. Linear regression was used to examine the association between OSTRC-P Questionnaire severity score and patellar tendinopathy severity rating during single leg decline squat.
Results: The final analysis included 169 players who completed both tests. The OSTRC-P Questionnaire had a sensitivity of 79% (95% CI: 65%-90%), specificity of 98% (95% CI: 94%-100%), positive PV of 95% (95% CI: 83%-99%), negative PV of 92% (95% CI: 86%-96%), positive LR of 48 (95% CI: 12-191) and negative LR of 0.21 (95% CI: 0.12-0.37). The post-test probabilities were 95% (95% CI: 83%-99%) for positive and 8% (95% CI: 5%-13%) for negative results. Exploratory analysis investigating the effect of age groups revealed a sensitivity of 83% and specificity of 99% in older players (16-18 years) and a sensitivity of 50% and specificity of 97% in younger players (13-15 years). A positive association was found between OSTRC-P Questionnaire and patellar tendinopathy severity rating during single leg decline squat {[$\beta = 0.08$ (95% CI: 0.03-0.12) ($P = 0.001$)]}.
Conclusions: The OSTRC-P Questionnaire is an acceptable alternative to clinical evaluation for self-reporting patellar tendinopathy in settings involving youth basketball players. However, current findings suggest that the OSTRC-P Questionnaire is not a sensitive tool for reporting patellar tendinopathy in players younger than 16 years.
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Effect of Beta-Blockers in Sport: A Systematic Review

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Objective: To determine the effects of beta-adrenergic blocking agents (beta-blockers) in enhancing athletic performance.

Data Sources: We searched 2 databases (EMBASE, MEDLINE) for trials from their beginning to December 2017. Any published trial that used randomized assignment to the intervention and control groups in full text and measured beta-blockers as an independent variable were included. All articles were either included or excluded in the review based on inclusion/exclusion criteria. Reports of randomized controlled trials, including crossover trials specifically in relation to the use of beta-blockers for its ergogenic were included.

Main Results: In this review, qualitative analysis of 24 studies showed that beta-blockers significantly reduced heart rate, and qualitative analysis of 17 studies showed that beta-blockers significantly reduced blood pressure in comparison to placebo. One study reported that beta-blockers significantly improved pistol shooting performance, which was hypothesized to be a result of the beta-blocker eliminating emotional increases in heart rate and blood pressure. Additionally, qualitative analysis of 21 studies showed that beta-blockers significantly reduced athletic performance (eg, maximal oxygen uptake, maximal workload, total exercise duration).

Conclusions: There was evidence suggesting that beta-blockers decreased athletic performance in some capacity. However, there was also evidence that beta-blockers decreased heart rate, blood pressure, and improved pistol shooting performance, and these effects may provide an advantage in precision sports (eg, archery, shooting). Owing to the limited number of studies that investigates the effect of beta-blockers on performance in precision sports, there is a need for further high-quality RCTs with larger sample sizes to provide stronger justification of current and future doping policy based on the effects of beta-blockers on athletic performance.

Interdisciplinary Shoulder Pain Team Model: Cross-Section Analyses of Patients Seen by a Same-Day Collaboration of Sports Clinic Practitioners

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Objective: At the GSSMC, we aim to evaluate our novel interdisciplinary team approach to patients with shoulder pain via surgical wait times, access to necessary treatment at 3- and 6-months, and patient satisfaction at 6 months. We present a comparison of our enrolled participants at recruitment and 3-months follow-up.

Study Design: Program Evaluation, Survey Research.

Subjects: Patients (≤18 years of age) who have been referred to a GSSMC Shoulder Clinic. A cross-section of our current Baseline and 3-Month follow-up data (May 29, 2017-January 20, 2018) was analyzed for descriptive statistics; *t* tests were conducted to determine statistical significance.

Intervention: GSSMC orthopedic surgeons triaged and scheduled all referred patients with shoulder pain into either Surgical (SURG) or non-surgical (Sports and Exercise Medicine, SEM) clinics. Clinics consisted of orthopedic surgeon + physiotherapist or SEM physician + physiotherapist teams. Both groups saw the patient together and collaborated on a care plan. We collected patient responses via the WORC, WOSI, and DASH validated shoulder pain questionnaires initially and at 3- and 6-months (Patient Satisfaction survey distributed at 6-months).

Outcome Measures: Referral-to-Appointment Time, WORC/WOSI/DASH scores, Treatments Received.

Results: We report no difference in wait-times between SEM and SURG patients ($P > 0.67$). We currently find SEM patients to more likely not be working (18/31, 58.06%) and retired (15/31, 48.38%) as opposed to SURG patients (42/177, 23.72%; 18/177; 10.17%, respectively). SURG patients are significantly more likely to have changed jobs due to shoulder pain (17/177; 9.60%). Three-month WOSI scores were significantly higher for SURG than SEM patients ($P < 0.03$). No significance differences are currently seen at Baseline or at 3-months post-visit for the WORC and DASH scores. Of patients reporting at 3-months, physical therapy (SEM 28.6%; SURG 54.5%), steroid injections (SEM 33.3%; SURG 4.5%), and surgery (SEM 0%; SURG 15.9%) were most pursued since consultation. Six-month follow-ups are in progress.

Conclusions: Patient profiles at 3-months reveal SURG patients to more likely be working and with a higher WOSI score, and SEM patients more likely to be retired and receive steroid injections for their shoulder pain. Our study is presently limited by the imbalance of patients between SURG/SEM.

Management of Concomitant Rotator Cuff Pathology and Adhesive Capsulitis—A Systematic Review of Indications, Treatment Approaches, and Outcomes

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Objective: Coincident adhesive capsulitis (AC) and rotator cuff pathology poses significant therapeutic challenges, in light of contrasting postoperative rehabilitation goals. This review explores strategies for assessment, management, and rehabilitation in concomitant rotator cuff tear (RCT) with AC, focusing on clinical outcomes.

Data Sources: In accordance with PRISMA guidelines, 3 databases (MEDLINE, EMBASE, and Pubmed) were searched and screened in duplicate using predetermined criteria for studies on concomitant RCT + AC. Descriptive statistics are presented.

Main Results: Of 951 studies, 17 involving 652 shoulders, of mean age 59.6 ± 3.5 years, 57.9% female, and mean follow-up 18.6 ± 0.9 months were included. Criteria for AC were defined in 10 studies (63.5%), with significant variation in allowable range of motion (ROM). Capsular release (CR) (85.9%) and manipulation under anesthesia (MUA) (33.6%) were the most common co-interventions performed with rotator cuff repair (RCR). Significant improvement was seen between pre- and postoperative measurements for the following: Constant score from 47.0 ± 2.6 to 85.6 ± 4.5;

ASES score from 35.1 ± 2.2 to 85.6 ± 7.1; pVAS from 6.6 ± 0.3 to 1.4 ± 0.1. One study compared 33 shoulders undergoing concomitant RCR + CR against 30 shoulders undergoing staged preoperative rehabilitation, followed by CR, then RCR. Both groups underwent identical postoperative rehabilitation emphasizing early ROM. At final follow-up, no significant between-group differences in clinical outcomes (ROM, ASES, Constant, or pVAS) were reported. In most studies, postoperative rehabilitation comprised abduction braces (81.9%) and passive ROM (100%) in early postoperative periods, then active ROM (90.6%) and strengthening (89%). Return to activity was reported in 10 studies (59.2%) at 21.6 ± 1.9 months. Postoperative complications included residual stiffness (41.7%), cuff re-tear (37.5%), multidirectional instability (8.3%), glenoid fracture (8.3%), and joint infection (4.2%), with no humeral fractures. Six re-tears (66.7%) required revision RCR, and 3 persistently stiff shoulders (30%) required CR.

Conclusions: Definitions of concomitant RCT + AC are inconsistent and may create undesired variability in this population. Nevertheless, this review supports MUA/CR and RCR for treatment of concomitant AC + RCT, with no apparent differences in outcomes for staged versus nonstaged interventions. Although residual stiffness and cuff re-tear are potential postoperative complications, a cuff repair rehabilitative protocol may be beneficial to ensure biological healing, and avoid the arguably more challenging revision RCR.

Immediate Effects of Kinesiotaping on Acromiohumeral Distance and Shoulder Proprioception in Individuals With Symptomatic Rotator Cuff Tendinopathy

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Objective: To investigate the immediate effects of kinesiotaping on the acromiohumeral distance (AHD) and shoulder proprioception in individuals with rotator cuff tendinopathy (RCTe).

Study design: Observational study (cross-sectional design).

Subjects: Twenty-three individuals (14 men, 9 women; age: 29.0 ± 6.6 years, height: 1.77 ± 0.12 m; body mass: 74.4 ± 14.2 kg) with symptomatic RCTe were recruited.

Observation Technique: Proprioception was measured through active joint repositioning in low-range (45-65 degrees) and mid-range (80-100 degrees) during shoulder flexion and abduction. A wireless inertial measurement unit system was used to quantify shoulder angles. The AHD was measured using an ultrasound scanner in 2 arm positions [at rest (0 degree) and 60 degrees shoulder abduction]. First, measurements were taken without kinesiotaping. Thereafter, therapeutic kinesiotaping for RCTe was applied on the symptomatic shoulder, and the same measurements were retaken. Two- or three-way repeated measures ANOVAs were used for statistical analyses.

Results: For AHD, a significant 2-way interaction between intervention and angle was found ($P = 0.013$). Kinesiotaping provided a significant improvement in AHD at 60 degrees shoulder abduction (ΔAHD = 0.94 mm 95% CI: 0.50-1.38, $P < 0.001$), exceeding the minimal detectable change (0.70 mm). There was no significant difference at rest ($P = 0.299$). For active joint repositioning, the ANOVA for repeated measures revealed no significant 2-way or 3-way interactions among the factors examined in both low-range and mid-range ($P > 0.05$).

Conclusions: The application of kinesiotaping had no immediate effect on low-range and mid-range active joint repositioning in individuals with RCTe, whereas it led to an immediate increase in AHD at 60 degrees shoulder abduction. Further studies are needed to determine how much these effects are clinically meaningful for symptomatic individuals with RCTe.

Physical Activity Monitoring in Youth Following a Concussion

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Objective: The purpose of this study is to compare levels of physical activity and rest to determine if there is coherence between self-reported and objectively monitored (Actigraph) physical activity in youth ice hockey players following a concussion.

Study Design: Case-series nested within a cohort study.

Subjects: Twenty participants (16 males, 4 females, median age 14 years; range 12-16) diagnosed with a sport-related concussion while playing ice hockey were included in this study.

Observation Technique: Participants self-reported minutes spent in various activity intensities using the Modified Daily International Physical Activity Questionnaire (MDIPAQ) and wore an Actigraph accelerometer over the course of 3 days following the initial diagnosis of concussion by a sport medicine physician.

Outcome Measures: Time spent (minutes) in sedentary, light, moderate, and vigorous physical activity levels based on self-report using the MDIPAQ and Actigraph accelerometry.

Results: Pearson correlations between the Actigraph accelerometer and MDIPAQ for all 4 exercise intensities ranged from 0.09 for light intensity to 0.79 for vigorous intensity. Bland Altman plots with 95% limits of agreement show large intervals and poor agreement between Actigraph recording and participant self-report on MDIPAQ.

Conclusions: There is poor agreement between the Actigraph and MDIPAQ over the first 3 days of recovery for sedentary and light intensities, with higher levels of correlation ($r = 0.57$; $r = 0.79$) demonstrated for moderate and vigorous intensities respectively. Actigraph accelerometry is a more objective determinant of physical activity compared to self-report when

worn properly and may provide a more accurate measure of activity in youth who have suffered a concussion. Physical activity and rest may have an influence on an individual's recovery acutely following concussion, accurate representations are vital in determining the association between activity and favorable outcomes following concussion.

Clinical Outcomes and Complications of Primary Reverse Total Shoulder Arthroplasty After 2010: A Systematic Review

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Objective: Given increasing indications and surgeon experience with primary reverse total shoulder arthroplasty (rTSA), the purpose of this review was to evaluate how the clinical outcomes and complications of rTSA have changed since 2010. Given these considerations, it is expected that the rate of major complications would decrease in rTSA.

Data Sources: Three electronic databases (MEDLINE, EMBASE, and PubMed) were searched and systematically screened in duplicate from January 1, 2010 to September 6, 2017 for English-language, human studies, of all levels of evidence that examined outcomes and complications of rTSA.

Main Results: The final 11 of 913 studies included 725 patients [25% male; mean age: 74.1 years (50-88); mean follow-up: 1.85 years (2 weeks-4 years)]. Indications included acute fractures (47.9%), rotator cuff tear arthropathy (42.2%), fractured sequelae (5.3%), massive rotator cuff tear (3.8%), and osteoarthritis (0.8%). Postoperative range of motion included a mean 122 degrees forward elevation, 100 degrees abduction, 34 degrees external rotation, and 42 degrees internal rotation. Post-operative patient-reported outcomes included a mean Constant score of 56.9, ASES score of 76.9, SST score of 63.5, and a VAS Pain score of 3.4. The overall complication rate was 15.7% (114 in 725 patients), encompassing "minor" (eg, scapular notching (25.6% vs 35.4%; post-2010 vs pre-2010), periglenoid radiolucent lines (25.8% vs 2.9%), heterotopic ossification (7.4% vs 0.8%), and miscellaneous (11.6% vs 1.5%) complications. "Major" complications requiring revision included humeral fracture (2.2% vs 1.4%), humeral stem loosening (1.8% vs 1.3%), dislocation (1.4% vs 6.2%), and cubital tunnel syndrome (1.4% vs 1.2%), while those treated conservatively included neuropraxias (13%), acromion fracture (2.9% vs 1.5%), and superficial infection (1.2% vs 3.8%). Comparing this newer data to that pre-2010, the overall rate of these "major" complications has decreased from 15.4% to 3.6%.

Conclusions: While the clinical implications of minor complications remains unknown, the decrease of major complications is highly relevant to perioperative discussions regarding risks and patient expectations as well as shared decision making. However, further studies and large registry data with longer follow-up is necessary to identify if alterations in prosthesis design and surgical technique have improved outcomes.

Effect of Erythropoietin in Sport: A Systematic Review With Meta-Analysis

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Objective: To determine the effects of Erythropoietin (EPO) in enhancing athletic performance.

Data Sources: We searched 3 databases (EMBASE, MEDLINE, and SPORTDiscus) for trials from their beginning to June 2017. Any published trial that used randomized assignment to the intervention and control groups in full text and measured Erythropoietin as an independent variable were included. All articles were either included or excluded in the review based on inclusion/exclusion criteria. Reports of randomized control trials, including crossover trials specifically in relation to the use of EPO for its ergogenic effect, were included. Studies were categorized according to duration of observation period and dosage. Meta-analysis was performed in categories with 2 or more studies and low heterogeneity.

Main Results: In this review, quantitative and qualitative analyses showed that in the short-term, low-doses of EPO significantly improved maximal power output, as well as that hematological parameters (ie, hematocrit percentage, hemoglobin concentration) and pulmonary measures (ie, absolute $\dot{V}O_2$ max, relative $\dot{V}O_2$ max) were significantly improved in the short-term by low, medium, and high-doses of EPO. This review also showed that high-doses of EPO led to significant improvements in athletic performance (ie, TTE, maximal power output, and pulmonary ventilation). Additionally, this review showed that low-doses of EPO significantly improved RPE, total work, and hematocrit percentage in the intermediate-term.

Conclusions: There was evidence suggesting that low, medium, and high-doses of EPO can have ergogenic effects in the short and intermediate-term depending on the outcome measured. However, there was insufficient evidence to support the effect of EPO during submaximal exercise, which may be more relevant to performance in endurance sports competitions. Owing to the limited number of studies that investigates this distinction, there is a need for further high-quality RCTs with larger sample sizes to provide stronger justification of current and future doping policy based on the effects of EPO on athletic performance.

The Effect of Load Carriage and Recovery on Shoulder Strength

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Objective: To determine fatigue-related changes in shoulder strength after 2 hours of loaded walking, and to determine the time needed for shoulder strength to recover.
Study Design: Observational Cross-sectional study.
Subjects: Thirteen healthy volunteers (3 females, 10 males) with (age 27 ± 5.3 years; weight 82.5 ± 11.8 kg; height 180 ± 5.6 cm; BMI 25.5 ± 3.5 kg/m^2), all subjects were right-handed.
Intervention: Dominant arm abduction strength was assessed at baseline and at (0, 10, 20 and 30) minutes post-backpack walking task. Walking task was administered in lab settings, subjects carried a 25 kg backpack and walked for 2 hours on a treadmill with no inclination, and speed (5.5-7 km/h).
Outcome Measures: The shoulder strength was the average torque (N·m) produced by the shoulder in first 2 to 5 seconds of isometric abduction. The strength was assessed isometrically by the BTE dynamometer (BTE Primus; Hanover, Maryland). Familiarization practice was done at baseline only for 6 seconds. The same tester conducted all testing for the 13 subjects, giving the same level of motivation at each test.
Results: We have found a significant reduction in shoulder abduction strength measures from (57.5 ± 16.8 N·m) at baseline, to (44.5 ± 13.5 N·m) after 2 hours of backpack walking with (P = 0.002). Shoulder strength needed 30 minutes to recover (45.7 ± 15.7 N·m), with (P-value > 0.05).
Conclusions: Walking with a heavy backpack for 2 hours reduced significantly shoulder strength. Subjects needed 30 minutes to be able to recover full shoulder strength. Carrying heavier loads and walking for long periods of time, especially in a military and climbing population, might affect shoulder strength and lead to shoulder injuries if 30 minutes of recovery was not allowed.

Associations Between Sleep Quality and Self-Reported Health Problems in Female Pre-professional Ballet and Contemporary Dancers

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Objective: To determine the association between sleep quality and self-reported health problems in female pre-professional ballet and contemporary dancers.
Study Design: Cohort.
Subjects: A convenience sample of 21 female pre-professional ballet [n = 11, median age 14.7 years (range 12.2-19.2)] and contemporary [n = 10, median age 20.3 years (range 18.2-22.8)] dancers participated.
Observation Technique: Measures of sleep were obtained using a wrist-worn actigraph over 5 consecutive nights part way through the dance training year. Sleep duration (hrs: mins), wake time after sleep onset (hrs: mins) and sleep efficiency (%) [(total sleep time/time in bed) × 100] were collected. Self-reported health problems [ie, any musculoskeletal (MSK) complaint or illness leading to difficulties participating in dance; yes/no] and dance exposure (hrs) were captured by a weekly online questionnaire (modified Oslo Sports Trauma Research Centre Questionnaire on Health Problems) during the training year.
Outcome Measures: Descriptive statistics [mean/median, standard deviation (SD)/range] and multivariable logistic regression were used to examine the association between sleep efficiency and self-reported health problems, accounting for total hours of dance exposure.
Results: Ballet dancers were followed for 30 weeks and contemporary dancers for 19 weeks. Sixteen of 21 dancers (76%) reported at least one health problem during the study period (ie, 14 dancers reported at least one MSK complaint; 10 reported at least one illness). Dancers slept for a mean of 8.4 hours (SD 0.8) per night over the 5-day recording period and spent a median of 1.1 hours (range 0.6-2.4) awake after sleep onset per night. Median actigraph-measured sleep efficiency was 84.5% (range 71.0-99.9). Mean self-reported quality of sleep (out of 5) rated 3.5 (SD 0.6) over the same period. There was no association between sleep quality and self-reported health problems ($\beta = -0.002$, 95% CI −0.04 to 0.04).
Conclusions: The prevalence of health problems among pre-professional dancers is high and their quality of sleep is considered poor (sleep efficiency score <85%). While there was no association found between sleep quality and reported health problems in this sub-sample, a larger sample is required for further investigation of sleep and fatigue-related factors contributing to the high risk of injuries and illness in dance.

Shoulder Pain Referrals: Assessment of Pre-Referral Management and Adequacy of Referral Detail in a Community Setting

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Objective: To determine the quality of referral detail and pre-referral management prior to referral to a shoulder specialist and determine factors predictive of surgery.
Study Design: Retrospective chart review.
Subjects: Two hundred subjects (125 males and 85 females) identified from the orthopedic surgery patient registry.
Observation Technique: Original referrals and initial visit clinic notes were examined for patient demographics, referral source and quality, clinical history, extent of conservative therapy, wait time to index visit and orthopedic diagnosis.
Outcome Measures: Referral detail and clinical information from referrals and clinic notes were used in a multivariate regression to identify predictors of surgical candidacy. Proportion of patients with an adequate course of anti-inflammatory medication, strength based physiotherapy and trial of joint injections were identified to determine the extent of conservative therapy.
Results: The average amount of detail in a shoulder pain referral is 5.89 items out of a maximum of 13. There was no correlation with wait time or significant predictive effect of referral detail with surgery. Shoulder pain duration for less than 6 months was associated with shorter wait times. Functional impairment (LR 3.3) and full thickness rotator cuff tears were significant predictors of surgical candidacy. Conversely, pain duration greater than 6 months (LR 0.3) was less likely to result in surgical candidacy. Optimal courses of anti-inflammatories and physiotherapy were prescribed 26%

and 24% of the time respectively. Joint injections were performed on 36.5% of patients.
Conclusions: The majority of referrals to a shoulder specialist do not receive adequate non-operative management and are lacking in information. Improving the details in a referral, especially regarding functional impairment and treatment to date, may improve triage ability and wait times for shoulder complaints.

Workload and Patellar Tendinopathy in Youth Basketball

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Objective: To investigate the association between workload (WL) and patellar tendinopathy (PTP) in youth basketball players. A secondary objective was to explore the association between jump count and sessional rating of perceived exertion (sRPE).
Study Design: Nested case–control.
Subjects: One hundred fifty-one players (aged 13-18 years) from 15 youth club basketball teams. Players were pre-screened into PTP cases and no PTP (controls) using the Oslo Sport Trauma Research Centre Patellar Tendinopathy (OSTRC-P) Questionnaire.
Observation Technique: Player WL was monitored for a 1-week period including all practices, games and conditioning sessions, during their regular club basketball season.
Outcome Measures: Jump count was measured using a wearable jump device (VERT 2.0). sRPE was collected immediately after each session. Simple linear regression analysis with adjustment for clustering by team and Bonferroni correction was used to examine mean differences in measures of WL including cumulative jump counts (external WL), basketball sessions completed (external WL), and sRPE in arbitrary units (AU) (internal WL) between cases and controls. In addition, a simple linear regression analysis was used to explore the association between jump WL and sRPE.
Results: A total of 144 players (19 PT cases, 125 controls) met inclusion for final analyses. Point estimates suggest that players with PTP had a higher jump count [mean difference (95% CI): 45 jumps (−22 to 112)], completed more basketball sessions [mean difference (95% CI): 0.9 (−0.7 to 1.9)], and had higher sRPE [mean difference (95% CI): 309 AU (−364 to 981)] than controls, though these findings were not statistically significant. Significant positive association was found between players' jump WL and cumulative sRPE internal WL, as demonstrated using a linear regression analysis [$\beta = 4.74$ (95% CI: 3.02-6.46) ($P < 0.001$; $R^2 = 0.20$)].
Conclusions: Current findings suggest that, although not statistically significant, youth basketball players with PTP may have higher internal and external workload than those without PTP despite the presence of symptoms. Further research is needed to fully understand the association between WL and PTP and other common overuse injuries in youth basketball.
Acknowledgments: This study is part of larger cohort study funded by the National Basketball Association and General Electric for prevention of injury and protection of athlete health.

Return to Sport Following Hip Arthroscopy: A Systematic Review and Meta-Analysis

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Objective: The purpose of this systematic review was to evaluate the rate at which patients return to sport following arthroscopic hip surgery.
Data Sources: The databases MEDLINE, EMBASE, and PubMed were searched by 2 reviewers, and titles, abstracts, and full-text articles screened in duplicate. English-language studies investigating hip arthroscopy with reported return to sport outcomes were included. A meta-analysis of proportions was used to combine the rate of return to sports using a random effects model.
Main Results: Overall, 38 studies with 1773 patients (72% male), with a mean age of 27.6 years (range 11-65) and mean follow-up of 28.1 months (range 3-144) were included in this review. The pooled rate of return to sport was: 93% [95% confidence interval (CI) = 87%-97%] at any level of participation; 82% (95% CI = 74%-88%) at pre-operative level of sporting activity; 89% (95% CI = 84%-93%) for competitive athletes; 95% (95% CI = 89%-98%) in pediatric patients; and 94% (95% CI, 89.2%-98.0%) in professional athletes. There was significant correlation between a shorter duration of preoperative symptoms and a higher rate of return to sports (Pearson correlation coefficient = −0.711, $P = 0.021$).
Conclusions: Hip arthroscopy yields a high rate of return to sport, in addition to marked improvement in pain and function in the majority of patients. The highest rates of return to sport were noted in pediatric patients, professional athletes, and those with a shorter duration of preoperative symptoms.

Psychometric Evaluation of the Scat Symptom Evaluation in Adolescents Using Rasch Analysis

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Objective: The objective of this study is to evaluate the SCAT for its psychometric properties using Rasch Analysis.
Study Design: Retrospective cohort study.
Subjects: Eighty-four males between the ages of 13 and 18 (mean 15.2 ± 1.6).
Intervention/Observation Technique: A total of 243 completed SCAT symptom evaluation responses from concussed adolescents were collected as part of a larger study and subjected to Rasch Analysis usingRUMM 2030. The SCAT was evaluated against the Rasch Model which allowed for the evaluation of the reliability and validity of polytomous scales.
Outcome Measures: The SCAT symptom evaluation was evaluated for goodness of fit to the Rasch model by analyzing the items for unidimensionality to ensure each only represents one underlying construct, for item bias to ensure homogeneity of responses, for disordered category thresholds to determine if the response options represent distinct levels of the item, for response dependency between items and for reliability using the Person Separation Index.
Results: Out of the 22 symptoms, 4 of the symptoms were identified as being problematic and not fitting the Rasch Model (neck pain, feeling like "in a fog," difficulty remembering and irritability). Elimination of the 4 miss-fitting symptoms resulted in the remaining 18 symptoms fitting the Rasch Model. This implies that the 4 symptoms in question that did not fit the Rasch model are problematic and do not necessarily represent the underlying construct they claim to be measuring.
Conclusions: The validity and reliability of the SCAT symptom evaluation as it currently exists cannot be confirmed as 4 of the 22 items were identified to be misfitting to the Rasch model. As the removal of these items resulted in the remaining 18 items fitting the Rasch Model this would indicate that the underlying construct being evaluated by the misfitting items requires further evaluation.

The Clinical Effectiveness of Autologous Blood and Platelet-Rich Plasma (PRP) in the Treatment of Tendinopathy. A Systematic Review and Meta-Analysis of Randomised Controlled Clinical Trials

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Objective: Tendinopathies are common in the population. There are increasing numbers of clinical studies referring to Platelet-Rich and Platelet-poor (PRP and PPP) as a treatment for tendinopathy. This is a systematic review and meta-analysis of the outcome of the PRP groups by PRP preparation method and injection technique in tendinopathy. The aim was to determine clinical effectiveness of the preparations and to evaluate the effect of controls.
Data Sources: The data bases of PubMed, EMBASE, CINAHL and Medline were searched in March 2012 and updated in April 2014 and August 2015. Randomised controlled trials using autologous blood, PRP, PPP or autologous conditioned plasma in tendinopathy with outcome measures of pain and follow-up time of 3 months were included. Trials including surgery, tendon tears, muscle, ligament injuries were excluded. The review and meta-analysis was performed according to the PRISMA guidelines. Study quality was assessed using the Cochrane collaboration risk of bias tool by 2 reviewers. Data was pooled using random effects meta-analysis. The primary outcome measure was a change in pain intensity. Where more than one pain scale was included, we selected a functional score ahead of a visual analogue score.
Main Results: A total of 18 studies (1070 Subjects) were included. Eight were deemed to be at low risk of bias. The most significant outcome in the PRP groups was those treated with highly cellular leucocyte-rich preparations: PRP-GPS (SMD 35.75 CI 28.4-43.10), Mycells-PRP (SMD 31.84 CI 17.56-46.13), Prosys-PRP (SMD 42.99 CI 37.73-48.25), unspecified LR-PRP (SMD 34.62 CI 31.69-37.55). When the LR-PRP system types are grouped there is a strongly positive effect: LR-PRP (SMD 36.38 CI 34.0-38.77) when compared to leucocyte poor PRP (LP-PRP) SMD 26.77 CI 18.31 to 35.22. In assessing the control groups: there was no clear difference between different types of control injections saline (SMD 14.62 CI 10.74-18.5), Local anaesthetic (SMD 15.00 CI 7.66-22.34), Cortisone (SMD 23.82 CI 10.74-18.5) or Dry Needling (SMD 25.22 CI 21.27-29.16).
Conclusions: There is good evidence to support the use of a single injection of leucocyte-rich PRP in tendinopathy. Both the preparation and intra-tendinous injection technique of the PRP are clinically significant.

Development of a Clinical Pathway for Patients With Rotator Cuff Disorders

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Objective: To develop a clinical pathway for patients presenting with chronic disorders of the rotator cuff (RCD) to primary, secondary, and tertiary care in Alberta.
Study Design: Phase 1: Expert consensus methods; phase 2: Prospective, descriptive survey using the Healthcare Access and Patient Satisfaction Questionnaire (HAPSQ) and Rotator Cuff Quality-of-Life Index (RC-QOL).
Subjects: Phase 1 included 14 experts representing sport medicine, orthopaedic surgery, and complimentary allied medicine. Phase 2 consisted of 171 patients presenting to the University of Calgary Sport Medicine Center (n = 96) and University of Alberta Glen Sather Sports Medicine Centre (n = 75).
Intervention: Phase 1 employed modified Delphi consensus methods to establish clinical practice guidelines for the diagnosis and treatment of RCD. In phase 2, 2 groups of patients were invited to complete the HAPSQ and RC-QOL. Group 1 patients did not require immediate surgical management and were treated conservatively with a non-operative rehabilitation program. Group 2 patients were surgically treated.
Outcome Measures: In phase 1, a systematic review was performed to generate a draft document. The document was circulated over 2 rounds of email questionnaires and discussed

during a final face-to-face meeting. In phase, 2, the questionnaires were used to collect patient-reported quality-of-life scores, waiting times, patient satisfaction scores, healthcare utilization, and costs. Results from phase 2 (ie, the current standard of care) were evaluated against clinical practice guidelines and clinical pathway algorithms developed in phase 1 (ie, the ideal standard of care).

Results: In Phase 1, 59 consensus statements were developed around 5 clinical domains: screening, diagnosis, physical examination, investigations, and treatment. Clinical pathway algorithms were also defined for acute, chronic, and acute-on-chronic RCD. In phase 2, one patient (0.01%) met the ideal standard of care for non-operative treatment, and only 40 patients (46%) received surgery within the benchmark timeframe.

Conclusions: The clinical practice guidelines and clinical pathway algorithms developed in phase 1 will serve to decrease variance in practice across the continuum of care for patients presenting with RCD. The comparison of existing performance measures in the current state with best practices in the ideal state will help to identify gaps and provide recommendations for improvement.

Extraction Drilling Versus Serial Dilation for Tibial Tunnel Preparation in Anterior Cruciate Ligament Reconstruction: A Systematic Review

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Objective: This review examines existing clinical and biomechanical outcomes of both extraction drilling (ED) and serial dilation (SD) as a technique for tibial tunnel preparation in ACLR.

Data Sources: In accordance with PRISMA guidelines, 3 electronic databases (MEDLINE, EMBASE, and PubMed) were searched and systematically screened in duplicate from database inception to September 6, 2017 for English-language, human studies, of all levels of evidence that examined ED and/or SD for tibial tunnel preparation in ACLR. Data including patient demographics, tibial tunnel preparation techniques, biomechanical and clinical outcomes and complications were retrieved from eligible studies.

Main Results: ED was used in 71 patients, who were mean age 29.9 years (range: 17-50), 68% male, and followed for mean 16.5 months (range: 3.8-46). SD was used in 70 patients (70 knees), who were mean age 29.3 years (range: 18-50), 69% male, and followed for mean 14.1 months (range: 3.8-46). There were no statistically significant differences (mean preoperative; mean postoperative) for either tibial preparation technique for Lysholm (50.1; 92.5), Tegner (3.5; 6.1), International Knee Documentation Committee (IKDC) (48.8; 92.7), and Lachman or laxity scores. However, ED demonstrated statistically significant increased postoperative tibial tunnel expansion (1.8 mm vs 1.4 mm) and (at 12 weeks) graft migration at the tibial fixation site (1.3 vs 0.8 mm). Across biomechanical studies, there were no statistically significant differences (ED; SD) with forces required to initiate graft slippage (156 N; 174 N), graft stiffness (187 N; 186.5 N), and screw torque (1.6 N/m; 1.8 N/m). ED demonstrated a lower mean load to failure for the graft construct (433 N vs 631 N; $P < 0.05$).

Conclusions: Though biomechanical data demonstrated lower mean load to failure for the graft using ED, clinical data suggest increased tibial tunnel expansion and post-operative graft migration at tibial fixation site. Future studies with long-term follow-up data are required to better ascertain the optimal technique for graft incorporation and postoperative success.

Level of Evidence: IV: Systematic Review of Level I-IV studies.

Primary Allograft ACL Reconstruction in Skeletally Immature Patients—A Systematic Review of Surgical Techniques, Outcomes and Complications

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Objectives: Both the diagnosis and surgical reconstruction of anterior cruciate ligament (ACL) injuries in the skeletally immature population is on the rise. Due to physeal considerations, traditional graft sources have encompassed either soft-tissue auto- or allograft. This systematic review aims to ascertain the risk profile of soft-tissue allografts in primary ACL reconstruction of skeletally immature patients.

Data Sources: Three databases (PUBMED, EMBASE, and MEDLINE) were searched from database inception to June 2017 for English-language literature, of all levels of evidence, addressing primary ACL reconstruction in skeletally immature patients (ie, open femoral and tibial physes). Inclusion criteria encompassed the use of allograft tissue with available postoperative outcomes data. Article screening, data abstraction and quality assessment were completed in duplicate, with descriptive statistics presented.

Main Results: After screening 3852 studies, nine studies—examining 406 skeletally immature patients of mean age 14.9 ± 1.2 years, and followed-up mean 59.6 ± 17.4 months—satisfied the inclusion criteria. The majority (98%) of included patients underwent complete transphyseal ACLR. Where specified, allograft options included Achilles tendon (66.5%), tibialis anterior tendon (7.6%), bone-patellar tendon (2.5%) and fascia lata (1.0%). Postoperatively, and where specified, patients achieved full range of motion (12.1%), had good Lysholm scores of 94 to 100 (8.1%), and a return to pre-injury level athletic participation of 82.9% (8.4%). Complications (13.3%) included graft failures (7.9%), non-revision reoperation (4.7%) and a combined leg-length discrepancy and angular deformity (0.2%). There were no reported incidences of disease transmission.

Conclusions: Although failure rates of primary allograft ACL reconstruction are acceptable compared to other studies of mainly autograft use in this young, high risk population, there was a very low rate of clinically significant physeal damage. However, the relatively low quality of the included studies limits the ability to recommend routine use of allograft for ACLR in the skeletally immature patient. More robust studies with long-term follow-up data are necessary to better ascertain

the influence of allograft choice on postoperative outcomes for these young patients.

Physical Activity, Adiposity, and Strength in Children With Spastic Cerebral Palsy Compared to Their Typically Developing Peers: A Pilot Cohort Study

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Objective: To examine differences between children with spastic cerebral palsy (CP) and typically developing (TD) children in physical activity (PA) intensity levels [sedentary, light, and moderate-vigorous (MVPA)], proportions meeting MVPA guidelines, adiposity [fat mass index (FMI)], and maximum lower-extremity isometric strength.

Study Design: Cohort study.

Subjects: Sixteen children with CP [10 males, mean age: 15.53 ± 2.84 years, gross motor function classification system (GMFCS) level I (n = 5), II (n = 3), III (n = 2); 6 females, mean age: 15.49 ± 2.44 years, GMFCS level I (n = 6)] and 16 sex- and age-matched (within 1 year) TD children participated.

Observation Technique: ActiGraph accelerometers (wGT3X-BT) were worn around the waist for 7 days, dual-energy x-ray absorptiometry, and hand-held dynamometry were used to measure PA, adiposity, and strength, respectively.

Outcome Measures: PA is categorized as proportion of daily time spent sedentary, in light PA, or in MVPA. FMI was based on participants whole body fat mass and height (kg/m^2). Strength of 8 different muscle groups was measured and reported as torque normalized to body weight (N·m/kg). Wilcoxon signed-rank tests were used to assess within-pair differences.

Results: PA did not differ between female CP and TD cohorts. TD males spent significantly more time in MVPA ($z = 2.429$, $P = 0.0152$) compared to males with CP. MVPA in all children except one TD male was below the recommendations for promotion of healthy habits and prevention of long-term morbidity. FMI did not differ for males ($z = -0.051$, $P = 0.9594$) or females ($z = -1.153$, $P = 0.2489$) between cohorts. TD males were significantly stronger with all muscle groups except dominant hip extensors ($z = 1.886$, $P = 0.0593$) and dominant ankle dorsiflexors ($z = 1.274$, $P = 0.2026$). Two female participants with CP were unable to produce force using their non-dominant ankle dorsiflexors. Females with CP were only weaker than their TD counterparts using their ankle plantarflexors ($z = 2.201$, $P = 0.0277$).

Conclusions: Larger sample size will be required to determine the influence of severity of physical impairment on differences examined between CP and TD children by sex. Further multivariable analyses to examine the association between outcomes (eg, PA, adiposity, strength) can inform the development of multimodal rehabilitation aimed at improving the long-term health of children with CP.

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Can Pre-Operative Magnetic Resonance Imaging Predict Intra-Operative Autograft Size for Anterior Cruciate Ligament Reconstruction? A Systematic Review

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Objective: This systematic review explored the utility of preoperative magnetic resonance imaging (MRI) as a tool for predicting intra-operative graft size for anterior cruciate ligament (ACL) reconstruction. Though multifactorial, graft size has a significant influence on post-ACL reconstructive biomechanical and clinical outcomes, and revision rates.

Data Sources: Three databases (EMBASE, PubMED and MEDLINE) were searched in November 2017 for English-language studies of all levels of evidence that aimed to correlate preoperative MRI measurements of common primary ACL autograft sources to intraoperative measurements of the harvested graft. Two reviewers completed a title, abstract, and full-text review of eligible studies. Searched studies were evaluated using inclusion and exclusion criteria after which data was extracted.

Main Results: A systematic screen of 930 titles resulted in 14 studies satisfying inclusion/exclusion criteria. These studies examined 762 patients of mean age 28.6 (9-67), with 37.3% females. Comparing the correlation of preoperative MRI measurements to intraoperative harvested measures, the strength was very highly positive for quadriceps tendon (1 study, 29 patients, ICC = 0.96); highly positive for patellar tendon (2 studies, 28 patients, ICC: 0.77-0.87); negligible-highly positive for semitendinosus-only tendon (8 studies, 439 patients, r: 0.16-0.81); and negligible-moderately positive for gracilis-only tendon (4 studies, 143 patients, r: 0.29-0.59). When combined semitendinosus-gracilis tendon grafts were considered, the correlation ranged from low-very highly positive (10 studies, 517 patients, r: 0.42-0.93).

Conclusions: Pre-operative MRI assessment of both quadriceps and bone-patellar tendon-bone autografts most highly correlate with intra-operative measurements of autograft diameter. Considerable variability exists when viewing hamstring tendons either individually or together, where most

studies indicate at least a moderate correlation. Thus, in addition to confirming ACL rupture and concomitant pathology, the pre-operative MRI can prove invaluable to orthopedic surgeons' pre-operative planning process, better facilitating optimal autograft selection to minimize adverse outcomes. Further attention is required to standardizing both the pre-operative and intra-operative measurement approaches.

The PRECISION Survey: Preferences of Physicians Regarding Image-Guided Joint Injections

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Objectives: Current literature suggests that ultrasound guided intra-articular injection (UGII) may be more accurate than non-image guided intra-articular injections (NGII). Despite this, the majority of physicians use NGII. Thus, the objectives of this survey study were to: (1) determine practice patterns, (2) assess beliefs and attitudes towards UGII, (3) identify barriers to the use of UGII, and (4) determine any differences in beliefs and attitudes based on age or specialty.

Data Sources: A survey was developed using a focus group of that included a statistician and 164 physicians who regularly perform intra-articular injections of the knee, shoulder and/or hip. Following validation by the focus group, the final survey contained 28 questions and was e-mailed to members of the Canadian Academy of Sport and Exercise Medicine for completion (N = 632).

Main Results: A total of 168 responses were received (26.6%). Nearly half of respondents rarely or never had access to UGII equipment (48.5%), and over half did not have adequate training to perform UGIIs (56.8%-68.8%). About half of respondents agreed that UGII improves accuracy in knee injections (50.9%); only 35.4% agreed there was evidence to support UGII over NGII of the knee. Physicians younger than 50 year old were significantly more likely to use UGII for the knee and hip if they had better access to equipment ($P < 0.0005$ for both); they were more likely to use UGII for the knee if it was less time-consuming ($P = 0.001$).

Conclusions: The majority of physicians surveyed are not using ultrasound guidance for the injections of the knee and shoulder, though some are using UGII for the hip. Physicians appear to over-estimate their accuracy performing NGIIs. The 3 biggest barriers to use of ultrasound for guided intra-articular injections were identified as: (1) inadequate training; (2) lack of access to equipment; and (3) lack of time. Younger physicians appeared to be more open to adopting UGII if these barriers were addressed.

Marijuana and its Effects on Athletic Performance: A Systematic Review

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Objective: To determine the effects of marijuana on athletic performance.

Data Sources: Six databases (MEDLINE, EMBASE, CINAHL, PsycINFO, AMED, and SPORTDiscuss) were searched from their beginning to September 2016 for any primary study which included adults of any athletic background between ages 18 and 65. Studies must have used marijuana cigarettes and included a control group.

Main Results: Three trials examined marijuana and its effects on athletic performance. Two trials had a high risk of bias and one trial had an unclear risk of bias. The effect of marijuana on outcomes including heart rate, blood pressure, and exercise duration remains unclear. Low quality evidence suggests that treatment, sham, and inactive control groups do not have a significant difference for grip strength. Low quality evidence suggests that there is an ergogenic effect of treatment demonstrated by increased bronchodilation and forced expiratory volume in one second compared with inactive control and that there is an ergolytic effect of treatment demonstrated by decreased physical work capacity compared with sham and inactive control groups.

Conclusions: Because the number and quality of studies was low, the effects of marijuana on athletic performance remain unclear.

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Evaluating the Consistency and Agreement of Scores Across 2 Measurements of the Visual System: Test-Retest Reliability

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Objective: Vision function is suggested to play a role in concussion and can be measured with binocular vision tests (BVTs). Our objective is to determine the one-week test-retest reliability of 10 BVTs proposed for concussion patients.

Study Design: Prospective observational study.

Subjects: Twenty healthy participants (11 females with 1 lost at follow-up, 10 males) with a mean age of 25.5 (SD = 4.0) years.

Observation Technique: One clinician examined each participant with 10 BVTs at their earliest convenience (T1), and one week after T1 (T2). The investigated BVTs measure: 3D vision [gross stereoscopic acuity (GSA)], saccades, anatomic deviation (AD) at 30 cm and 3 m, double vision [near point of convergence—fusional (NPCf)] and the ability of the eyes to focus in-sync [near point of convergence (NPC), binocular fusion with convergence (BFC) and divergence (BFD) at 30 cm and 3 m].

Outcome Measures: The primary outcome measure is the one-week test-retest reliability of 10 BVTs. We judged an intraclass

correlation coefficient (ICC) of ≤0.5 as poor, 0.51 to 0.74 as moderate, 0.75 to 0.89 as good, and ≥0.90 as excellent reliability. We present 95% limits of agreement (LoA) for the % difference (T1-T2)/mean of the scores (average of the scores T1 & T2).

Results: Our ICC results suggest good reliability for AD 3 m (0.88), and moderate reliability for GSA (0.62), AD 30 cm (0.69), NPC (0.54), NPCf (0.64), and both BFC (0.54) and BFD (0.66) at 30 cm. There was poor reliability for saccades (0.34), and both BFC (0.49) and BFD (0.43) at 3 m. LoA was best for saccades (±34%) and worst for AD 30 cm (±121%), and ranged from ±58% to ±70% for 7/8 other tests. For AD 3 m, the distribution was highly skewed, thus, LoA uninformative. In brief, 18/20 pairs of measurements were identical, and for 2 other pairs, one scored 0 and 1, the other scored 0 and 2.

Conclusions: Our findings demonstrate moderate to good reliability for 7/10 BVTs, and poor reliability for saccades, and BFC and BFD at 3 m. To be clinically useful in concussion management, the LoA results suggest that concussion must have a moderate to large effect on the scores of most BVTs.

Both Soft-Tissue and Bone-Plug Quadriceps Tendon Autografts Are Comparably Efficacious Options for Primary Anterior Cruciate Ligament Reconstruction

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Objective: This systematic review examines the outcomes and complications after primary ACLR with either all-soft-tissue quadriceps tendon (S-QT) or bone-plug quadriceps tendon (B-QT) autograft.

Data Sources: In accordance with PRISMA guidelines, PubMED, EMBASE, and MEDLINE were searched in September 2017 for English-language, human studies of all levels of evidence on patients undergoing primary ACLR with either S-QT or B-QT autograft. Data regarding postoperative outcomes and complications were abstracted.

Main Results: Of 1320 studies screened, 24 satisfied inclusion/exclusion criteria. Five studies reported on use of S-QT on 202 patients (202 knees) of mean age 36.3 years (range: 15-58) with mean follow-up of 24.8 months (range: 12-29.5). Twenty-one studies reported on use of B-QT on 1456 patients (1464 knees) of mean age 28.7 years (range: 15-59) with mean follow-up of 35.2 months (range: 12-120). A meta-analysis could not be performed due to heterogeneous reporting, and instead data were summarized descriptively. Anterior-posterior stability (evaluated by mean side-to-side difference in mm with KT-1000) was comparable between S-QT and B-QT, at 1.1 and 1.6, respectively. IKDC subjective scores were also comparable between S-QT (80.4) and B-QT (85.3), as were Lysholm scores (89.0 and 91.2, respectively). B-QT studies reported a mean return to sports rate of 86%; no S-QT study reported return to sports rates. Rates of kneeling pain were 11% for S-QT and 8% for B-QT patients. The most common complication for both S-QT and B-QT was graft rupture, occurring in 3.0% and 2.4% patients, respectively. Overall quadriceps tendon (QT) failure rate was 2.4%. Three patellar fractures were noted with B-QT (1.9%).

Conclusions: The QT, whether S-QT or B-QT, demonstrates success rates comparable to other commonly used autograft sources (eg, bone-patellar-tendon-bone, hamstrings). Clinical outcomes after primary ACLR with either graft are comparable as far as post-operative knee pain, objective and subjective function, and complications. Still, the available evidence does not definitively demonstrate one mode of graft preparation to be superior to another. Future studies are needed to directly compare S-QT and B-QT grafts.

Comparing the Clinical Presentation of Acute Knee Injury Patients With and Without a Complete Anterior Cruciate Ligament Tear: Implications for Development of a Diagnostic Clinical Support Tool

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Objective: Compare the clinical presentation of acute knee injury patients, with and without an ACL-rupture, to inform the development of a clinical decision support tool.

Study Design: Retrospective Cohort Study of electronic medical records (EMRs).

Subjects: The EMRs of all patients aged 15 to 45 years, with ICD-9 codes corresponding to intra-articular knee injuries and a confirmed or denied ACL-rupture through one-of-three criterion standards seen at a University-based sports medicine clinic between January 2014 and July 2016 were eligible for inclusion.

Observation Technique: Data were manually extracted from individual EMRs by research personnel, and then audited for accuracy by one research team member, using a customized data extraction instrument developed with healthcare providers.

Outcome Measures: Extracted data included demographics, relevant diagnostic indicators (injury details, clinical and diagnostic-imaging examination findings, care pathway), and ACL status (ie, ACL-rupture = ACL^+ or ACL non-rupture = ACL^-) by 3 criterion standards (orthopaedic surgeon assessment, MRI and/or surgery). Missing data were identified and descriptive statistics [mean or proportion (95% CI) or median (range)] were calculated for all outcomes and summarized by ACL status and criterion standards. Between group comparisons were made with 95% CI.

Results: Of 1510 potentially relevant records 734 were included. Participant mean age was 27.4 years (range 15-45), 47.4% were female and 63.2% had an ACL-rupture based upon at least one criterion standard. Age, sex and body-mass-index did not differ between study groups. A greater proportion of patients in the ACL^+ group sustained a plant-pivot mechanism of injury [ACL^+ 28.7% (24.5, 33.4): ACL^- 10.1% (5.5, 17.8)], reported a pop [ACL^+ 57.0% (52.0, 61.7): ACL^- 32.3% (23.8, 42.2)], pain [ACL^+ 62.0% (57.1, 66,6): ACL^- 41.4% (32.1, 51.4)], swelling [ACL^+ 82.1% (78.0,

85.6): ACL^- 49.5% (39.7, 59.3)] or inability to continue their activity [ACL^+ 39.5% (34.8, 44.5): ACL^- 19.2% (12.5, 28.2)] at the time of injury, and demonstrated a positive Lachman [ACL^+ 91.2% (88.0, 93.6): ACL^- 2.0% (0.5,6.9)] or pivot shift [ACL^+ 76.8% (72.4, 80.7): ACL^- 4.0% (1.5, 10.3)] test. Finally, 82.2% (78.4, 85.5) of ACL^+ and 93.8% (90.3, 96.0) of ACL^- patients underwent MRI.

Conclusions: These findings suggest that there is no single diagnostic indicator for ACL-ruptures and a heavy reliance on MRI for diagnosis. Future research aimed at improving ACL-rupture diagnosis should focus on validation of a clinical decision support tool that considers multiple diagnostic indicators.

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Is Team-Based Musculoskeletal Assessment Associated With Better Healthcare Outcomes? A Systematic Review

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Objective: The primary objective of this review was to assess the association between team-based musculoskeletal (MSK) assessments aimed at directing patient care and healthcare quality indicators (HQIs). Secondary objectives included determining which healthcare practitioners most commonly comprise MSK-assessment teams, level of team collaboration, and most commonly assessed HQIs.

Data Sources: Five electronic databases (Medline, EMBASE, CINAHL, Sport Discus, SCOPUS) were systematically searched using keywords and Medical Sub-Headings terms. Studies selected included: English language; original data; participants with a MSK condition that underwent a team-based (2 or more healthcare providers) assessment in a primary or intermediate care setting aimed at directing treatment; and a HQI outcome (ie, acceptability, accessibility, appropriateness, effectiveness, efficiency, safety). PRISMA guidelines were followed and 2 independent raters assessed study quality [Downs and Black (DB) criteria] and level of evidence (Oxford Centre of Evidence-Based Medicine model).

Main Results: Of 1159 potential relevant studies, 10 were included. The majority (6/10) of these were low quality pre-experimental studies (level 4 evidence), with significant bias [median DB score 13.5/32 (range 6-18)], and only 4/10 included a comparison assessment group. The most common MSK condition assessed was hip fracture (3/10 studies). Heterogeneity in methodology and HQI assessed precluded meta-analyses. Teams were most commonly comprised of a physiotherapist and another healthcare pracitioner (eg, occupational therapist, primary care physician, social worker). Most teams (7/10 studies) demonstrated a low level of collaboration (eg, members assessed the patient and developed discipline specific treatment plans independently). Pain scores (3/10 studies) and length-of-stay (LOS; 3/10 studies) were the most common HQI investigated. Limited low-level evidence suggests that team-based MSK assessment may be associated with improved clinical outcomes (ie, pain, quality-of-life) and reduced hospital LOS, admission rate, and time to meet discharge criteria.

Conclusions: There is limited low-level evidence to suggest that team-based MSK assessment may positively impact healthcare quality indicators including; accessibility (admission rate, LOS), appropriateness (admission rate, LOS), effectiveness (pain, quality-of-life scores), and efficiency (admission rate, LOS, time to meet discharge criteria). Further high quality studies that include comparison to alternate assessment models and economic analyses are required before recommending widespread implementation of team-based MSK assessment.

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No Difference Between Full-Thickness and Partial-Thickness Quadriceps Tendon Autografts in Anterior Cruciate Ligament Reconstruction: A Systematic Review

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Objective: The purpose of this systematic review was to compare outcomes and complications of primary ACL reconstruction (ACL-R) performed with either full-thickness (FT-Q) or partial-thickness (PT-Q) quadriceps tendon autografts.

Data Sources: PubMED, EMBASE, and MEDLINE were searched as per PRISMA in September 2017. The studies were systematically screened in duplicate for English-language, human studies of all levels of evidence on patients undergoing ACL-R with either FT-Q or PT-Q autografts and available postoperative outcomes data. Due to the heterogeneity across the reported outcomes, descriptive statistics are presented.

Main Results: Upon screening 3670 titles, 18 studies (50% case–control, 50% case series) satisfied inclusion/exclusion criteria. These studies examined 1183 patients (1190 knees) of mean age 27.2 years (range 15-59) and mean follow-up 41.7 months (range 6-120). FT-Q and PT-Q autografts were used in 12 studies (60% of knees) and six studies (40% of knees), respectively. Instrumented laxity was less than 3 mm in 73.8% of the FT-Q group (5 studies, 554 knees) and 74.3% of the PT-Q group (5 studies, 230 knees). Range of motion was restored within 5 degrees of full extension for 95.1% of the FT-Q group (4 studies, 357 knees) and 95.2% of the PT-Q group (2 studies, 106 knees). The mean postoperative Lysholm scores were 90.9 and 91.9 for the FT-Q (5 studies, 404 knees) and PT-Q (six

studies, 372 knees) groups, respectively. The overall rates of graft failure were 3.7% in FT-Q (3 studies, 504 knees) and 5.1% in PT-Q (2 studies, 117 knees), and 3.9% across all studies (5 studies, 621 knees).
Conclusions: Across available data, there appears to be no difference in outcomes or complications between either FT-Q or PT-Q in primary ACL-R. While larger, multi-center comparative studies are needed to better delineate the optimal thickness of quadriceps tendon for primary ACL-R, this data suggests that, in primary ACL-R, either FT-Q or PT-Q are efficacious and surgeons may be justified in using either graft thickness. Moreover, given the low rate of graft failure and favorable outcome profiles of ACL-R with quadriceps tendon autografts, this data supports the use of quadriceps tendon autografts in primary ACL-R.

Graft Fixation for All-Soft Tissue Quadriceps Tendon Autograft in Anterior Cruciate Ligament Reconstruction: A Systematic Review

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Objective: The purpose of this systematic review was to compare aperture versus suspensory fixation techniques for femoral and tibial quadriceps tendon (QT) autograft fixation in primary anterior cruciate ligament reconstruction (ACL-r) and the clinical outcomes and complication profiles of each technique.
Data Sources: As per PRISMA guidelines, a comprehensive search of PubMED, EMBASE, and MEDLINE was performed in September 2017 to identify English-language, human studies of all levels of evidence on patients undergoing ACL-R with all-soft tissue QT autograft that had information on graft fixation and postoperative clinical outcomes data available. Titles, abstracts, and full texts were screened in duplicate. Due to the heterogeneity in the reported data, descriptive statistics are presented.
Main Results: Upon screening 1320 articles, 5 studies satisfied inclusion/exclusion criteria. These studies (20% prospective comparative studies, 60% prospective case series, 20% retrospective case series) examined 202 SQT ACL-R's of patients with mean age 33.9 years (range, 15-58) and mean post-operative follow-up 16.6 months (minimum, 12 months). Femoral and tibial-sided SQT fixation were performed by aperture fixation on both sides in 88.8% of patients and suspensory fixation on both sides in 11.2% of patients. SQT autografts with suspensory fixation had a higher percentage of patients (90%) achieving the highest rating of "A" on the IKDC Knee Ligament Examination form compared to aperture fixation (32.2%). SQT autografts fixed with suspensory fixation had a lower side-to-side difference in anterior laxity (1.0 mm) when compared to aperture fixation (1.6 mm). Among studies which reported graft failure, which all used aperture fixation, a total of 5 patients (2.5%) experienced graft failure.
Conclusions: Across available clinical data, the 2.5% overall failure rate for ACL-R using QT autograft is low in comparison to other common autograft sources. However, there is insufficient evidence to recommend an ideal method of graft fixation, either aperture or suspensory, on the femoral and tibial sides during SQT ACL-R. Although more biomechanical/cadaveric data are needed to test the numerous fixation options with this graft choice, ultimately, larger randomized control trial studies (RCTs) are required with long-term follow-up data to delineate the optimal method for femoral and tibial-sided fixation.

Hip Morphological Risk Factors for Anterior Cruciate Ligament Injury: A Systematic Review

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Objective: Given its frequency/burden, there are ongoing efforts to optimize both treatment and prevention of anterior cruciate ligament (ACL) tears, with increased attention on the influence of knee bony morphology as a risk factor. Considering the influence of adjacent joints and the kinetic chain, however, this review aims to understand the association between hip joint morphology and ACL tears in skeletally mature patients.
Data Sources: A systematic review was conducted following PRISMA guidelines to determine the association between hip morphology and ACL tear risk. EMBASE, MEDLINE and PubMed were searched from database inception to September 2017.
Main Results: Thirteen of 6210 studies were included with a median MINORS quality score of 17 (9-23); 11 of which were prospective. The mean age was 26.1 years (16-60), with 25.5% female. Limitations in hip range of motion (8 studies, 846 patients) constituted the main hip morphological factor associated with increased risk of ACL injury, with 4 studies (691 patients) significantly associating decreased hip internal rotation (IR) with ACL tears (30.1 degree vs 42.1 degree in uninjured subjects). Only one study (50 patients) identified a significant association between hip external rotation (ER) and ACL tears (OR 0.23, 0.14-0.39), while 3 studies (367 patients) demonstrated significant associations with decreased total hip rotation (IR + ER) and ACL tear risk (73.8 degrees vs 82.6 degrees in uninjured subjects). Additional hip morphological factors associated with an increased risk for ACL injury included both radiographic AP and 45 degrees Dunn lateral alpha angles, with ACL injured patients demonstrating a significantly greater alpha angle (71.3 degrees and OR 2.7, 1.4-5.2, p 0.0001) than uninjured patients (55.6 degrees). Other parameters significantly associated included the clinical presence of increased pelvic tilt and diminished hip abduction/adduction strength, and radiographic hip center-edge angle, ischial spine sign, and pelvic tilt.
Conclusions: There exists a significant association between a variety of hip morphological factors and risk for ACL injury. Given the controversial benefit of neuromuscular training programs and prophylactic bracing for reducing injury risk, this study identifies additional structural parameters in adjacent joints that must be assessed and mitigated as part of the athlete screening process.

Single Bundle Over-the-Top ACL Reconstruction in Skeletally Mature Patients: A Systematic Review of Outcomes in Both Primary and Revision Settings

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Objective: Decades of research have been dedicated to optimizing various technical parameters of ACL reconstruction. This systematic review revisits the single bundle over-the-top (OTT) anterior cruciate ligament reconstruction (ACLR) technique, assessing outcomes and complication profiles.
Data sources: Two independent reviewers (M.S., A.S.) searched 3 online databases (PUBMED, EMBASE and MEDLINE) from inception to October 2017 for literature on OTT ACLR in skeletally mature patients. Major orthopedics conferences were also screened to identify additional studies. The systematic screening process was completed in duplicate, independently, and based on predetermined inclusion/exclusion criteria according with PRISMA and R-AMSTAR criteria for high-quality systematic reviews. Quality assessment of included RCTs was evaluated using the Consolidated Standards of Reporting Trials (CONSORT) tool, and non-randomized studies were evaluated using the Methodological Index for Non-Randomized Studies (MINORS) tool.
Main Results: From 3148 initial studies, 16 eligible studies (3 RCTs and 13 case series) satisfied inclusion criteria. Only 3 focused on the revision setting. The mean age of patients undergoing primary OTT reconstruction was 26.9 ± 3.6, with 18.5% female participants. In the revision setting, the mean age was 31.4 ± 1.23, (26.1% female). Of primary studies reporting on return to sport (n = 151), 51% of patients returned to pre-injury levels, with a total 94% returning to any level of sport activity. In the revision setting (n = 38), 66% of patients returned to their pre-injury level, and 34% returned to a lower level of sports participation. Primary reconstruction studies reported an average mean post-op Tegner score of 6.54 ± 0.54 (n = 181), and mean KOOS of 82.8 ± 8.1 (n = 96). In primary studies, a total 13 graft failures were reported (3.7%), 7 of which were re-ruptures (2%); whereas the revision failure rate was 8.4% (4 patients).
Conclusions: Clinically-important outcomes for OTT ACLR are comparable to reported literature for traditional all extra-articular, or transtibial/accessory anteromedial portal drilling techniques. This also holds true in revision settings, positioning the OTT technique as a versatile tool within the surgeon's arsenal, particularly in challenging primary/revision femoral tunnel scenarios.

Symptomatic Knee Osteoarthritis Treatment Using Adipose Derived Mesenchymal Stem Cells and Platelet-Rich Plasma: A Prospective Study

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Objective: The aim of this study was to evaluate the efficacy of administering adipose derived mesenchymal stem cells and PRP injections into patients with confirmed knee osteoarthritis.
Study Design: Prospective Study.
Subjects: Fifty-nine participants (30 males and 29 females, with a total of 70 affected Knees) diagnosed with knee osteoarthritis.
Intervention/Observation Technique: A total of 59 participants underwent a local tumescent mini-liposuction procedure to remove approximately 35 to 40 mL of lipoaspirate from the left buttock. The lipoaspirate was cleaned and concentrated using The Harvest AdiPrep Adipose Concentration System and resuspended in PRP (Harvest PRP system). The mixture was then injected into the suprapatellar bursa of the affected knee(s) under ultrasound guidance. All participants also received a PRP only injection "booster" (Arthrex PRP System) 1 to 4 weeks after the initial injection, again ultrasound guided into the suprapatellar bursa.
Outcome Measures: The Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to evaluate patient scores at baseline, 3 and 6 months.
Results: The average total KOOS improved from 55.1 at baseline to 69.9 at 3 months ($P < 0.001$) and 72.9 at 6 months ($P < 0.001$), representing a 36% increase in average KOOS at 3 months and 40.5% increase at 6 months. There was an average of 3.0 point difference in KOOS score from 3 to 6 months ($P < 0.03$) representing a 4.3% increase during this interval.
Conclusions: Adipose derived stem-cells with PRP appears to improve pain and function in osteoarthritic patients, and might postpone joint replacement. The patients tolerated the procedure well, and no adverse events were noted. The majority of improvements appear to occur in the first 3 months.

Effects of Patellar Tendon Strap Bracing on the Motor Performance and Biomechanics of Healthy Adolescent Athletes

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Objective: To determine the effect of patellar tendon strap (PTS) braces on physical performance of motor tasks (vertical jump, broad jump, box drop test and agility *t* test) in healthy adolescent athletes.
Study Design: Within-subject experimental design.
Subjects: Ten male and 10 female adolescent athletes (12-18 year-old), currently involved in sport, who do not have a current lower extremity injury/condition, injury within the past 6 months or previous lower extremity surgery.
Intervention: Subjects served as their own control and performed the following 4 tasks unbraced, followed by bilateral PTS bracing: (1) vertical jump test; (2) cross-cut test; (3) one leg broad jump; and, (4) agility *t* test.

Outcome Measures: Primary outcome measures included non-vector values of vertical jump height, single leg broad jump distance, and time achieved on agility *t* test. Secondary outcome measures involve sensor and force plate data collected during vertical jump height, single leg broad jump and cross cut, looking for changes in angles and force distribution amongst lower extremity joints.
Results: There was no statistically significant difference in the 95% CI in the change in motor performance between the braced and unbraced trials for vertical jump height, one-legged hop test distance or agility *t* test time. No statistically significant difference (CI 95%) in forces generated, joint moments, or joint angles during the execution of the motor tasks. Qualitative analysis of biomechanical data trends also revealed no difference in execution of tasks.
Conclusions: The execution of motor tasks commonly found in sport were not altered when healthy adolescent athletes applied bilateral PTS braces. Therefore, PTS braces may be recommended for athletes without consequent effect on performance.
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Labral Repair Versus Biceps Tenodesis for Primary Surgical Management of Type II Superior Labrum Anterior to Posterior (SLAP) Tears: A Systematic Review

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Objectives: Isolated Type II SLAP tears constitute an increasingly recognized pathology with significant controversy regarding the optimal surgical treatment. This systematic review aims to examine the outcomes of SLAP repair versus biceps tenodesis for the index surgical management of these injuries. We hypothesize that SLAP repair will show similar results to biceps tenodesis with regards to patient function and satisfaction.
Data Sources: In accordance with PRISMA guidelines, a comprehensive search of PubMed, MEDLINE and EMBASE was performed in October 2017 for all English-language studies that presented outcomes data on patients with isolated Type II SLAP tears treated with either SLAP repair or biceps tenodesis at the primary surgical time point.
Main Results: 22 studies (eg, 1 randomized control trial, 14 cohort studies, and 7 case series) were included. Isolated Type II SLAP tears were treated via SLAP repair in 740 patients with mean age 35 years (range 24-58 years) and a mean postoperative follow up of 30 months (range 3-63 months). Biceps tenodesis was performed in 61 patients with mean age 47 years (range 21-64 years) and a mean postoperative follow up of 37 months (range 24-75 months). The level of satisfaction was rated as "good to excellent" in 80% and 95% for SLAP repair and biceps tenodesis, respectively. The American Shoulder and Elbow Surgeons (ASES) score demonstrated statistically significant mean increases of 28 and 37 for SLAP repair and biceps tenodesis, respectively. A greater statistically significant decrease in Visual Analog Scale (VAS) pain scores was observed in patients undergoing biceps tenodesis versus SLAP repair. Return to sports was 62% for SLAP repair (263 patients) and 83% for biceps tenodesis (80 patients). Reoperation rates for SLAP repair and biceps tenodesis was 20% and 0%, respectively.
Conclusions: This study suggests that SLAP repair and biceps tenodesis have similar outcomes and complication rates in the context of isolated Type II SLAP tears. SLAP repair remains the most commonly performed index procedure especially for younger patients. Biceps tenodesis, however, appears equally efficacious, and may represent an attractive surgical alternative particularly for older patients. Further multi-centered, age-matched, randomized control studies are necessary to establish a consensus.

Attitudes of Sport Medicine Professionals Regarding Athletes With Impairment

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Purpose: The purpose of the research was to generate knowledge of experiences and attitudes of Canadian sport medicine professionals regarding athletes with physical and/or intellectual impairment. Para-sport athletes interact with medical professionals often throughout their careers. Understanding of the perspectives of sport medicine professionals regarding para-sport athletes will inform the delivery of sport medicine services, support high performance and potentially increase involvement.
Methodology: Electronic survey including quantitative and qualitative analysis.
Participants: Canadian Sport Medicine Professionals (n = 364).
Methods: In 2017, attendees of the CASEM 2017 were asked to complete an online survey regarding professional involvement with athletes with physical and/or intellectual impairment and views regarding para-sport. A mixed method approach to analysis was completed. Descriptive analysis of participant demographics is reported. Qualitative thematic analysis was conducted to discover dominant themes emphasizing words and phrases with a particular focus on constraints to involvement. Analysis was conducted until elastic saturation was reached and the research question was adequately addressed.
Results: At the time of abstract submission analysis of the data is ongoing. Preliminary analysis indicates that lack of knowledge regarding high performance para-sport athletes remains an obstacle for professional involvement with this population. A perceived inability to communicate effectively with athletes with intellectual impairment is the dominant explanation for non-involvement. Perceptions of impairment as inability or less able remain pervasive as well as a desire to take on the "challenge" of working with these athletes.
Conclusions: High performance para –sport athletes require the expertise of sport medicine professionals to maintain, prevent injury, and maximize high performance. Malcolm and Safia (2012) argued that the community of sportmedicine, a dynamic, responsive subset medicine has the expertise to

respond to a changing sporting community. Understanding perceptions will generate critical dialogue that deconstructs assumptions regarding athletes with impairment and creates new opportunities to meet the needs of this population of athletes.

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Evidence for Hip Arthroscopy: Review of the Literature and Grading of Current Indications

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Objective: The usage and indications for hip arthroscopy have expanded with improved technology. With emerging techniques, there is a need for continued research into indications and clinical outcomes. The purpose of this study was to review the current literature to provide an updated description of the Level of Evidence available to support hip arthroscopy for the current generally accepted indications and assign a grade of recommendation for each of them.

Data Sources: A comprehensive review of the literature was performed in April 2017 with the use of the PubMed and Embase databases. This review was an update from a previous study completed in 2010. The studies were systematically screened in duplicate for English-language, human studies that described clinical studies with a minimum of 2 years follow-up. The abstracts from 2257 were screened to isolate literature investigating the results of hip arthroscopy for different indications in the adult population. Ninety-three publications were identified that met inclusion and exclusion criteria. The studies were grouped based on indication and the literature supporting each indication was analyzed and assigned a Grade of Recommendation.

Main Results: There has been an increase in level II-III literature (grade B) to support a recommendation for the use of hip arthroscopy for the treatment of femoroacetabular impegement (FAI) as well as labral tears. There is grade C evidence to support several less common indications and emerging indications such as extra-articular pathologies, trauma, and infection.

Conclusions: There continues to be fair evidence (grade B) to support the use of hip arthroscopy for the treatment of FAI and labral tears. Evidence, however, is still lacking for the majority of recognized indications. Additionally, there is significant overlap between certain pathologies, which makes delineation of the evidence difficult. Higher-quality trials (level I-II) with long term follow-up are needed to provide support for the increasing application of this surgical technique. Level of Evidence: Level IV, systematic review.

Arthroscopic Superior Capsular Reconstruction for Massive, Irreparable Rotator Cuff Tears: A Systematic Review

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Objective: To systematically review and evaluate the effectiveness and complication profile of arthroscopic SCR as a technique to address MIRCTs.

Data Sources: A comprehensive search of 4 databases and conference abstracts of 4 major conferences was completed. Inclusion criteria consisted of clinical studies addressing SCR for large-to-massive rotator cuff tears. Two reviewers screened the titles, abstracts, and full articles and extracted the data from eligible studies. Data abstraction was performed in duplicate.

Main Results: A total of 8 studies (2 full-text, 6 conference abstracts) satisfied inclusion criteria. Three studies, one full text and 2 conference abstracts, reported results on the same patient cohort. Included studies examined a total of 344 patients (348 shoulders) with a mean age of 61.9 years and followed a mean 27.1 months post-operatively. There was statistically significant improvement in pain and function in all studies reporting results, with a frequency-weighted improvement of 46.8, 42.5, 37.4, and 3.4 points across the shoulder indices of American Shoulder and Elbow Surgeon Score, Japanese Orthopedic Association, Single Assessment Numeric Evaluation, and Visual Analog Scale, respectively. A frequency-weighted mean improvement of 56.8 degrees in abduction/elevation, 24.2 degrees in forward flexion, 14.5 degrees in external rotation was found among reportubg studies. Final follow-up improvement in post-operative acromio-humeral distance (AHD) was 3.2 mm increase. Across all studies, the combined clinical and radiographic failure/re-tear rate was 4.7%. No complications were reported.

Conclusions: Arthroscopic SCR may represent a viable surgical option for patients with MIRCTs, demonstrating short-term improvements in pain, range of motion, and function. Large, randomized control trial studies with long-term follow-up are required to better delineate the clinical indications, survivorship, and risk factors for failure in this population.

Portrayal of Mental Health Issues of Elite Athletes in United Kingdom Newspapers

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Introduction: There appears to be a greater focus and a national acceptance of mental disorders within the UK media. Added to this there has been various anti stigma campaigns from various sporting bodies highlighting sport as a means of treatment for mental health disorder and also sportspersons highlighting their own personal battles. Elite sportspersons have their own individual stressors leading to mental health issues and unique risk factors from the general population. Their coverage in mainstream media is important on influencing others who may be struggling and expansion of the wider understanding of the topic to health professionals.

Objectives: To examine the coverage of mental health issues of elite athletes in United Kingdom. national newspapers.

Methods: A content analysis was performed on articles published by the Guardian and Daily Telegraph newspapers throughout 2017. The articles were sampled for sport

highlighted, sex, current playing status, diagnostic focus and article type (news, feature and opinion), campaign exposure and treatment discussion.
Results: Seventeen differing sports were included in the analysis of 92 articles. Of these the football (n = 27), rugby union (n = 15) and cricket (n = 14) were the most common. The most common topics covered were depression (n = 38), concussion (n = 27) and cocaine use (n = 13). Sixty-nine out of 79 articles included male athletes. Exactly half were written about or by athletes still competing at an elite level. Most of the articles gave information about campaign and sources of help.
Conclusions: This study provides evidence that elite sportspeople have access to services and are aware of the various mental health campaigns. It challenges the perception of female athletes being more open with regards mental issues and reaffirms the worries and knock on effect of athletes coming to the end of their careers. There were no descriptions of adverse outcomes described and from the information analysed may or may not be an encouragement to others, although this appears to be part of the wider normalisation of the topic.

Are Canadian Family Medicine Residents Being Trained to Counsel Patients on Physical Activity? A Survey of Family Medicine Program Directors and an Opportunity for Improvement

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Objective: To assess the provision of physical activity teaching content in Canadian postgraduate family medicine residency programs.
Study Design: Descriptive survey.
Subjects: Sixteen of the 17 Canadian Family Medicine Residency Program Directors responded (94% response rate).
Intervention: A questionnaire/survey was designed and sent to all 17 Family Medicine Residency Program Directors across Canada. Answers were sorted either qualitatively or quantitatively and key themes identified. Questionnaire information was extracted from free text boxes about the specific teaching available and plans for future training, and overall number of hours and yes/no responses were tallied.
Outcome Measures: Response rates for overall participation and individual questions were recorded. Outcome measures included number of hours, content and structure of physical activity teaching in Canadian family medicine residency programs.
Results: Only 7 Canadian family medicine residency programs (44%) ensure that teaching regarding physical activity counselling is made available to future practicing family doctors. Only 8 (53%) currently provide teaching regarding the Canadian Physical Activity Guidelines. Specific content across programs varies considerably. Furthermore, only 2 Program Directors (18%) reported sufficient teaching on physical activity in their respective programs. Nine out of 10 Program Directors (90%) who responded to a specific question agreed that online educational resources developed to assist residents in physical activity prescription would be beneficial.
Conclusions: The extent of education regarding physical activity counseling in Canadian family medicine residency programs varies considerably from institution to institution. Most Family Medicine Program Directors report that their residency programs do not include mandatory education on physical activity counselling. It appears that most Program Directors would find online educational resources developed to assist residents in physical activity prescription beneficial. As family physicians are well-positioned to address physical inactivity as a modifiable risk factor to their patients, there is a critical need to equip our future physicians with the necessary knowledge and tools to address this epidemic and its resulting effects on the rates of chronic disease. Sport and exercise medicine physicians have specialized training in this area and as such may have an opportunity to assist with this need.

Clinical Assessment of Vestibulo-Ocular and Oculomotor Function in Youth Ice Hockey Players Compared to Symptom Provocation on the Vestibular/Ocular Motor Screening Tool

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Objective: The objective of this study is to examine the feasibility of and compare clinical assessment of vestibulo-ocular and oculomotor function to symptom provocation on the Vestibular/Ocular Motor Screening (VOMS) assessment tool in uninjured youth ice hockey players.
Study design: Feasibility and cross-sectional study.
Subjects: In total, 103 uninjured male and female youth ice hockey players (ages 10-17).
Observation Technique: Participants attended baseline testing sessions where they completed a preseason questionnaire and VOMs that included clinician observed performance ratings.
Outcome measures: VOMs (recording of symptom provocation following a series of tests) was compared to a newly created clinical assessment version of the VOMs that includes clinician observed performance on each subcategory of the VOMs.
Results: Participants were uninjured youth ice hockey players [n = 103; median age 13; range 10-17 years; 84.5% (87/103) male]. Previous concussion history was reported in 28% (29/103) of players. It was feasible to perform a clinical assessment of the VOMs in conjunction with reports of symptom provocation. In an uninjured state, 8% (8/103) of participants had symptom provocation following at least one test. With the

clinical assessment of VOMS performance, 62% (64/103) of participants showed abnormal performance on at least one test, of which only 1% (1/64) provoked symptoms following abnormal performance on the corresponding test. It was noted that 27% (17/64) of participants who had abnormal test performance and 25% (2/8) who had symptom provocation had a previous history of concussion, including the participant who had symptoms provoked on a test with abnormal performance.

Conclusions: Clinical assessment of VOMs is feasible to perform. Abnormal performance on the VOMS occurred in the absence of symptom provocation in most cases. Future study is recommended to better understand the mechanism by which symptoms occur during testing on the VOMS. A better understanding of typical oculomotor and vestibulo-ocular function in youth will assist in interpreting post-injury tests in youth ice hockey players.

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Association Between Knee Dynamic Valgus and Global Lower-Limb Strength in Healthy Females

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Objective: Knee dynamic valgus (KDV) during a vertical drop jump has been suggested as a risk factor for anterior cruciate ligament (ACL) rupture in female athletes. As KDV is a multi-joint and multi-planar movement, numerous muscles are involved in the control of this movement. In this study, we proposed to determine the association between KDV and the global strength of the antagonist muscles of KDV evaluated in a weight-bearing position.

Study design: Observational laboratory study.

Subjects: Forty-two healthy and physically active females were recruited (age: 20.8 ± 1.2 years, height: 1.65 ± 0.06 m, and body mass: 58 ± 6 kg).

Observation Technique: To determine the KDV, 3 vertical drop jumps (from a 31 cm – height box) were recorded using a high-speed video camera. The global strength of the antagonist muscles of KDV was measured with subjects standing in a semi-squat position. A strap was placed around the knees at the level of the lateral femoral condyles. A handheld dynamometer was positioned between the strap and the right lateral femoral condyle. The subjects were asked to push as strong as possible both knees against the strap. Both vertical drop jump and strength tests were performed in a randomized order.

Outcome Measures: The frontal plane projection angle was calculated at the first landing of the vertical drop jump to estimate the KDV. Maximal isometric strength of the antagonist muscles of KDV was reported.

Results: There was no statistically significant association between the frontal plane projection angle and the strength of the antagonist muscles of KDV ($P = 0.40$, rs = -0.038).

Conclusions: Although lower-limb muscles are involved in the control of the KDV during a vertical drop jump, no association has been found between the global strength of the antagonist muscles of the KDV and the KDV in healthy females.

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Epidemiology of Injuries in Youth Basketball

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Objective: To evaluate injury rates using an "all complaints" injury definition and specifically assess the season prevalence of patellar tendinopathy (PTP) and Achilles tendinopathy (ATP) in youth basketball players by sex.

Study Design: Prospective cohort study.

Subjects: A total of 512 youth basketball players (69 teams) (61% male) participated.

Observation Technique: Players were observed through one competitive high school (November 2016 to March 2017) and club (April to July 2017) basketball season, and followed up at the end of both seasons to record "all complaint" injuries–defined as any physical/musculoskeletal complaint leading to difficulties participating in basketball-related sessions including but irrespective of the need for medical attention or time-loss. In addition, PTP and ATP were specifically captured prospectively and at follow-up using an adapted Oslo Sport Trauma Research Centre questionnaire. All injuries were audited and duplicates removed.

Outcome Measures: Overall and sex-specific incidence rates (IR) measured as injuries/100 players/season with 95% confidence interval (CI) and season prevalence for PTP and ATP with 95% CI.

Results: A total of 415 independent injuries were reported (251 injuries in male and 164 injuries in female players), equivalent to an IR of 81.1 injuries/100 players/season (95% CI: 77.4-84.4); 79.9 in males (95% CI: 75.1-84.2) and 82.8 (95% CI: 76.8-87.8) in females. The IR for time-loss injury (92% acute onset) was 13.9 injuries/100 players/season (95% CI: 11.0-17.2); 10.5 (95% CI: 7.2-14.4) in males; 19.2 (95% CI: 14.0-25.4) in females. The IR of acute onset injuries was 43.8 (95% CI: 39.4-48.2) and overuse injuries was 37.3 (95%

CI: 33.1%-41.7%). The season prevalence of PTP was 19% (95% CI: 15%-22%); 22% (95% CI: 18%-27%) in males and 13% (95% CI: 9%-19%) in females. Season Prevalence of ATP was 4% (95% CI: 3%-6%); 4% (95% CI: 2%-7%) in males and 5% (95% CI: 2%-9%) in females.

Conclusions: Using an "all complaint" injury definition, injury rates in youth basketball are higher than previously reported with high occurrence of overuse injuries. Patellar tendinopathy is common among youth basketball players and more prevalent than Achilles tendinopathy. Injury prevention interventions are warranted to mitigate the burden of both acute and chronic injuries.

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Dizziness In Children and Adolescents With a History of Concussion: Symptoms and Functional Limitations

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Objectives: The objective of this study was to evaluate if cervical spine pain, headaches, dizziness symptoms, reported functional limitations, and balance confidence differ between youth with a history of orthopaedic injury (controls), youth who sustained one past concussion (>6 months since injury), and youth who have sustained more than one concussion (most recent >6 months ago).

Study Design: Cross sectional.

Setting: Alberta Children's Hospital, Calgary, AB, Canada.

Subjects: Youth aged 8 to 19 years with an orthopaedic injury (n = 29), one concussion (n = 23), or multiple concussions (n = 26).

Independent Variables: Participants were classified according to injury history and the sample included Orthopaedic injury, concussion, >1 concussion.

Outcome Measures: Participants completed a Numeric Pain/Dizziness Rating Scale (NPRS) (0-10 self report of cervical spine pain, dizziness and headaches), the Dizziness Handicap Inventory (DHI) (/100 where a higher score represents greater functional limitations due to dizziness), and the Activities-Specific Balance Confidence Scale (ABC) (/100 where a higher score represents greater balance confidence). A Kruskal–Wallis test was completed and after Bonferroni correction, alpha was set a priori at 0.01 (0.05/5 = 0.01).

Results: Participants had a median age of 14.2 years (IQR = 12.3-16.8) and median time since injury was 30.8 months (IQR = 17.4-41.8). The median score for NPRS was 0/10 (0-9/10) for all groups for symptoms. No significant groups difference were found for NPRS for dizziness [$\chi^2(2) = 3.35$, $P = 0.19$] or headache [$\chi^2(2) = 7.60$, $P = 0.02$]. However, individuals in the multiple mTBI group reported greater cervical pain [$\chi^2(2) = 11.56$, $P = 0.003$]. Median scores on the DHI for the orthopedic group was 2 (0-44), single concussion median = 2 (0-68) and multiple concussions median = 8 (0-44). The median ABC scores were: orthopedic group median = 99 (72-100), single concussion median = 98 (71-100), and multiple concussions median = 98 (38-100). No differences were noted in DHI or ABC scores between groups [$\chi^2(2) = 5.06$, $P = 0.08$ and $\chi^2(2) = 1.43$, $P = 0.49$ respectively].

Conclusions: Youth with a history of multiple previous mTBIs reported greater cervical pain. Future study to better understand potential longer standing symptoms and functional limitations following mTBI, as well as the underlying mechanism is warranted.

An Intervention Program Designed to Improve Balance and Power Acquisition in U14 Alpine Ski Racers (BASE Study)

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Objective: To determine if a neuromuscular training (NMT) warm-up program during preseason conditioning in ski-clubs would improve lower limb balance and power compared to the standard preseason program in alpine ski racers under 14 years of age (U14).

Study Design: Quasi-experimental design.

Subjects: Skiers included 73 U14 Alberta Alpine Ski Association (AASA) racers with 59 (54% male) in the intervention and 14 (50% male) in the control group during fall 2017.

Intervention: BASE is a NMT warmup program (15 minutes) consisting of agility and balance exercises designed to improve static and dynamic balance, and musculoskeletal power in youth ski racers. Coaches in the intervention clubs (n = 3) implemented BASE at the beginning of preseason training and continued until on snow training (10 weeks), while the control clubs (n = 2) completed their standard dryland training. Intervention coaches attended a workshop on the delivery of the NMT warm-up and onsite support occurred for the first few sessions.

Outcome Measures: Baseline and post preseason testing included: height (cm), weight (kg), waist circumference (cm), 20-m shuttle run, vertical jump (VJ-watts), prone hold (seconds), star excursion balance test (composite score, SEBT %), uni-pedal eyes closed dynamic balance test (seconds), and single-leg side hop timed test (10 jumps completed 30 seconds, SLHT).

Results: Two-way mixed ANOVA showed: (1) no significant group by time interaction effect VJ ($P = 0.963$), and SEBT% left ($P = 0.103$) and right foot ($P = 0.108$), (2) a significant time effect VJ ($P = 0.018$), (3) a significant group effect SEBT % left ($P = 0.004$) and right foot ($P = 0.002$), and (4)

a significant difference between groups at baseline SLHT (complete vs incomplete jumps) left ($P = 0.029$) and right foot ($P = 0.003$).
Conclusions: Dynamic balance and leg power improved over time for the intervention compared to the control group. Future research should involve more clubs and establish an injury surveillance system for this age group.
Acknowledgments: We acknowledge the athletes, parents, and administrative personnel in the AASA for their participation in this study. The U. of C. Sport Injury Prevention Research Centre is one of the International Research Centre's for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee.

Clinical Outcomes of Hamstring Autograft With and Without Allograft Augmentation for Anterior Cruciate Ligament Reconstruction: A Meta-Analysis

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Objective: There is mixed evidence to suggest that the augmentation of smaller diameter hamstring autografts with allograft tissues ("hybrid grafts") in anterior cruciate ligament reconstruction (ACLR) increases the likelihood of failure and need for revision surgery. This study sought to: (1) Report the clinical outcomes and rates of failure and need for revision surgery after ACLR with hamstring autograft (auto-ALCR) and hybrid grafts (hybrid ACLR), (2) Compare the incidence of graft failure and revision surgery for auto-ACLR and hybrid-ACLR.
Data Sources: A comprehensive search of PubMed, MEDLINE and EMBASE was performed in January 2018 for English-language studies of all levels of evidence pertaining to ACLR with hybrid grafts. A meta-analysis was conducted to compare the risk of graft failure and revision surgery between groups using the Review Manager 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration). Heterogeneity across the included studies was assessed using the I^2. A random effects model of risk ratios was used for the pooled analysis.
Main Results: Eight full texts were included after an initial screen of 336 titles. Six studies compared the incidence of graft failure in hybrid-ACLR and auto-ACLR. Return to play (RTP) rate was only reported in one study (hybrid-ACLR, 46% v. auto-ACLR, 50%, $P = 0.64$) 22 of 180 (12%) hybrid-ACLR were characterized as failures versus 21 of 226 (9%) auto-ACLR. Pooled analysis demonstrated a trend towards increased risk of graft failure in hybrid-ACLR (Pooled risk ratio = 1.61 [95% CI = 0.55-4.70], $I^2 = 50\%$, $P = 0.07$). Six studies compared the incidence of revision surgery in hybrid-ACLR and auto-ACLR. Overall, 31 of 221 (14%) revision surgeries were reported following hybrid-ACLR grafts versus 19 of 297 (6%) auto-ACLR. Pooled analysis demonstrated a trend towards increased risk of revision surgery in hybrid-ACLR (Pooled risk ratio = 1.97 [95% CI = 0.72-5.45], $I^2 = 52\%$, $P = 0.06$).
Conclusions: Rates of graft failure and revision surgery were comparable between hybrid-ACLR and auto-ACLR. However, trends towards increased rates of graft failure and revision surgery were noted among hybrid-ACLR. The augmentation of smaller diameter hamstring autografts with allograft tissue may predispose patients to suboptimal clinical outcomes after ACLR.

Radiographic Grading Scales for Post-Traumatic Osteoarthritis (OA)—How Reliable Are They for Identifying Changes in X-Rays of the ACL Reconstructed (ACLR) Knee?

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Objectives: (1) To determine the reliability and validity of radiographic grading scales in assessing OA changes in digital x-rays of ACLR knees in patients from a RCT. (2) To determine if a bias exists by blinding the observers from knowing the ACL deficient knee.
Study Design: Prospective diagnostic pilot study.
Subjects: Thirty-six sets of standardized digital knee images (Standing bilateral P-A 30 degrees flexed, lateral and skyline patella views) were randomly sampled from 903 complete series of images for baseline 2 and 5-year follow-up from ACLR patients. Four independent observers—undergraduate student, radiology resident, orthopaedic surgeon and musculoskeletal radiologist—graded all images. Observers were not given information on whether x-rays were baseline, 2- or 5-year follow-up. The bilateral P-A images were then blinded by digitally subtracting the ACL tunnels and fixation devices.
Observations/Outcome Measures: Three observers graded the unblinded x-rays using the Kellgren-Lawrence (KL), International Knee Documentation Committee (IKDC) and Osteoarthritis Research Society International (OARSI) published radiographic grading scales. Two ratings were performed 2 weeks apart. Two observers assessed the blinded images. The scales were evaluated for face, and content validity. Weighted kappa statistics were calculated for intra- and inter-rater reliability.
Results: Intra-rater reliability was substantial for the KL scale ($\kappa = 0.62$), and moderate to substantial for the IKDC ($\kappa = 0.47$-0.61) and OARSI ($\kappa = 0.43$-0.74). However, inter-rater reliability was less than moderate for all scales (KL: $\kappa = 0.42$; IKDC: $\kappa = 0.00$-0.48; OARSI: $\kappa = 0.00$-0.58). The observers noted that all scales lacked both face and content validity.
A newly proposed scale that looked at joint space narrowing, (none, detectable, obvious $\leq$50%, obvious >50%, bone-on-bone) and the presence/absence of osteophytes was subsequently proposed to address these deficiencies. Intra-rater reliability of the new scale was moderate to almost perfect ($\kappa = 0.42$-0.85).
Observers correctly determined the ACL deficient side 42% to 58% and 78% to 87% of the time in the pre-operative and post-surgical blinded x-rays, respectively.
Conclusions: The most commonly utilized OA rating scales have significant limitations when evaluating patients with ACLR. Intra-rater reliability is moderate to substantial, but inter-rater reliability is poor. Blinding observers by digitally subtracting surgical information is possible. A new rating scale is proposed and initial reliability is promising.

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Helmet Fit Assessment and Concussion Risk in Youth Ice Hockey Players Ages 11 to 18 Years

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Objective: To evaluate the association between validated helmet fit criteria and risk of concussion in youth ice hockey players.

Study Design: Nested case–control design.

Subjects: Preliminary data consists of helmet fit criteria measures for 46 concussed, 38 musculoskeletal (MSK) injured control, and 62 uninjured control (matched on age, sex, and level of play) ice hockey players ages 11 to 18 years (Pee Wee, Bantam, Midget) participating in a 5-year longitudinal cohort study "Safe2Play" during the 2017 to 18 season, Calgary, Alberta.

Observation Technique: Concussed, MSK injured, and uninjured players were administered helmet fit assessments using a previous validated measure, encompassing helmet specifications, condition, certification, and criteria measuring helmet fit for each individual.

Outcome Measures: Based on a validated injury surveillance system, cases included players with suspected and/or physician-diagnosed concussion. One control group included players sustaining MSK injuries resulting in time-loss from sport or medical attention. The second control group included players that remained uninjured. Proportion of youth ice hockey players in the concussion, MSK injury, and uninjured groups who met helmet fit criteria were compared.

Results: Twelve of 46 (26%) concussed players, 11 of 38 (29%) MSK injured players, and 16 of 62 (26%) uninjured controls met all 17 helmet fit assessment criteria. However, 27 of 46 (59%) concussed players, 16 of 38 (42%) MSK injured players, and 23 of 62 (37%) uninjured control player's helmets were missing 2 or more of the 17 assessment criteria. Future conditional logistic regression analysis will be used to examine the association between helmet fit criteria and odds of concussion.

Conclusions: Understanding the role of helmet fit for youth hockey players in the risk of concussion will inform helmet fit recommendations and potential policy change in youth ice hockey.

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A Randomized Clinical Trial Comparing Patellar Tendon (PT), Hamstring Tendon (HT) and Double-Bundle (DB) Hamstring ACL Reconstructions: Patient-Reported Clinical Outcomes at 5-Year Follow-up

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Objective: To compare reconstruction for isolated ACL deficiency using PT, HT or DB with hamstring tendon grafts, by measuring disease-specific quality-of-life outcome at 5-years post-operatively.

Study Design: Prospective, double-blind randomized clinical trial.

Subjects: Three-hundred thirty patients (183M; 14-50 years), with confirmed isolated anterior cruciate ligament deficiency.

Intervention: Patients were intra-operatively randomized (computer-generated, varied block), to anatomic ACL autograft reconstruction (110/group) with: PT (mean = 28.7 years), Quadruple-stranded HT (mean = 28.5 years), or DB using hamstring tendons (mean = 28.3 years). Patients and an independent trained examiner were blinded to treatment allocation.

Outcome Measures: Outcomes measured at baseline, 2 and 5-years. Primary: Anterior Cruciate Ligament Quality-of-Life (ACL-QOL). Secondary: IKDC subjective and objective scores, pivot shift, kneeling pain, Tegner activity, Cincinnati Occupational Scale, Single Leg Hop. Proportions of complete re-ruptures, partial re-ruptures and combined total traumatic re-injuries were compared.

An analysis of variance for repeated measures using Bonferonni post-hoc was used for mean outcomes; χ^2 analyses for categorical data. A 5% significance level was used.

Results: Three-hundred fifteen patients (95%) completed 5-year follow-up; 4 withdrawals, 11 lost-to-follow-up. Baseline characteristics between groups were not different. ACL-QOL scores increased from baseline for all groups ($P = 0.000$). Mean 5-year ACL-QOL scores were not different ($P = 0.548$): PT = 82.5 (SD = 17.9, 95% CI 79.0-86.0); HT = 83.9 (SD = 18.2, 95% CI 80.3-87.4); DB = 81.1 (SD = 19.3, 95% CI 77.4-84.8). At 5-years, the proportions of patients with a pivot shift grade ≥2 (PT = 11%; HT = 16%; DB = 22%) did not reach statistical significance ($P = 0.106$), but is clinically important.

None of the 5-year secondary outcomes were different between groups. Kneeling pain remained more common in the PT group (PT = 10/98; HT 4/98; DB 2/101; $P = 0.029$) but all groups had less kneeling pain at 5-years compared to baseline levels.

There were more complete traumatic graft ruptures in the HT and DB groups (PT = 4/103; HT = 11/105; DB = 11/107; $P = 0.145$) compared to patellar tendon reconstructions. Revision

ACL reconstruction was performed on 22 of these 26 patients. Eleven additional patients had partial graft re-ruptures (PT = 0; HT = 5; DB = 6) with cumulatively less traumatic re-injuries in the PT group (PT = 4; HT = 16; DB = 17, $P = 0.010$).
Conclusions: At 5-years, there was no difference in disease-specific ACL quality-of-life outcome between the 3 ACL reconstructions, but significantly more traumatic graft re-injuries in the HT and DB than the PT group.
Acknowledgments: Workers' Compensation Board—Alberta for funding support.

"I Don't Actually Know When I Knew it Was a Concussion": Athletes' Experiences of Concussion and Accessing Care

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Objective: The objective of this study is to qualitatively explore the experiences and perceptions of athletes pursuing concussions treatments in relation to broader social norms and values.
Subjects: Pre- and post-treatment semi-structured interviews were conducted with male- and female-identifying athletes and their parents/guardians.
Study Design: In collaboration with a randomized controlled trial evaluating cervical, vestibular and exercise rehabilitation following concussion in youth, treatment interviews were formatted to facilitate the collection of feedback on the clinical intervention, as well as to gain insights into athletes' experiences of concussion and the rehabilitation process. We then subjected the pre-intervention interview transcripts to analysis informed by (the limited) socio-cultural literature on sport-related concussion that exists at present.
Results: Common themes that emerged including the athlete and guardians' prolonged experience of finding, and accessing appropriate care following the concussive incident, the sense of abandonment by the very services meant to support their recovery, as well as excitement upon discovering new, and innovative, sources of support. We also present findings illustrating a (often taken-for-granted) reliance on medico-scientific knowledge in recovery and rehabilitation exploring how the medicalization of concussion can downplay the importance of the emotional/lived experience of this type of injury and its treatment.
Conclusions: Generally, access to care is felt to be challenging, while families found that identification of additional sources of support was of benefit. Consideration for the emotional/lived experiences was felt by participants to be an important aspect of injury that may be overlooked. Future research should consider these factors when developing clinical pathways and treatment protocols to create greater stakeholder engagement in treatment protocols, including those executed through randomized control trials.

Fists of Fury Without Injuries: Prospective Review of Hockey Fights in the NHL

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Introduction: At the prior Mayo Ice Hockey Summit on Concussion 2010, there was a unified call to end fighting in the NHL to reduce concussive injury. There has been no data to prove fighting actually leads to more concussions only anecdotal cases. This study will review the NHL experience and determine if a link exists between fighting and concussions.
Methods: A Prospective Analysis of NHL Fights from 2010 to 11 to 2012 to 13 seasons, recording all resulting injuries and outcomes, and number of games that the player missed. Public domain "Hockeyfight" web sites were used to identify and view all fights. All injuries were confirmed through 2 independent sources, the NHL and/or team or independent press source. In addition, the top 10 fighters annually for each of the past 5 years were evaluated for mTBI and all other injuries, using similar criteria to confirm findings. Players with any associated injury were excluded.
Results: The NHL had 992 fights in 1950 games over 2 seasons with a fight/game rate of: 50.9% (range 38%-65% annually in NHL over past decade). Thirty injuries resulted to the 1984 combatants (n = 992 fights) for an injury rate of 1.5/100 per fighters. Specifically looking at concussions, 6 mTBI resulted (20% of injuries) for a rate: 0.2/100 mTBI/fight rate. The 10 players with most fights in NHL annually, for the past 5 seasons, tallied 1012 fights from 50 players (fights/season range 17-33) with: all injury rate of 3/100 fights and mTBI rate of 0.15/100 fights.
Discussion: The concussion rate from fighting after review of both seasons and 5 seasons and 1000 fights from the top 10 fighters each year found a rate of 0.2/1000 fights which is 10 fold less than the reported concussion rates in NHL play (3.0 mTBI per 100 player games). Although fighting may appear a direct causative factor to concussions the data does not prove it. The difference of punching on ice compared to land appears to actually offer some protection over significant forces being generated and may explain the greater safety of fighting in the NHL without resultant injury.

Three-Dimensional Patellar Alignment in Individuals With Patellofemoral Pain in Weight-Bearing and Non-Weight-Bearing Conditions

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Objective: Two-dimensional (2D) analysis of the patellar orientation relative to the femoral condyles or the trochlea may limit our understanding of patellar orientation and position in

3D space. This study investigated three-dimensional (3D) patellar alignment in people with patellofemoral pain (PFP) and healthy individuals in non-weight-bearing (NWB) and weight-bearing (WB) knee extended positions. This study investigated three-dimensional (3D) patellar alignment in people with patellofemoral pain (PFP) and healthy individuals in non-weight-bearing (NWB) and weight-bearing (WB) knee extended positions.
Study Design: Case-Control Study.
Subjects: Participants were 10 healthy females (25.0 ± 7.7 years) and 8 females (29.7 ± 10.6 years) with a PFP and no clinical sign of patellar instability and patella Alta.
Observation: The most effected knees of the participants with PFP and one randomly selected knee of the healthy participants were imaged using a CT scanner in supine lying position. A dual-orthogonal fluoroscope was used to image the knee joint in a standing position. The CT scans were used to create a 3D geometrical model of the femur and the patella. The 3D coordinate systems were defined on each bone to quantify the patellar alignment relative to the femur. To measure patellar alignment in the WB condition, the 3D models were registered to the fluoroscopy images using the Fluomotion software.
Outcome measures: Six degree-of-freedom alignment of the patella. Insall-Slavati ratio.
Results: A significantly greater lateral tilt was found in the PFP participants compared with the healthy participants in the NWB ($F = 6.158$, $P = 0.025$) and the WB knee extended positions ($F = 13.678$, $P = 0.002$). In the WB knee extended position, a significantly larger superior patellar shift was observed in the PFP group ($F = 5.444$, $P = 0.033$). There were no significant differences between the patellar mediolateral shift and rotation between the groups ($P > 0.05$).The patellar height, measured in NW knee extension position, were in the normal range in the PFP (1.04) and the healthy group (0.96).
Conclusions: An abnormal alignment of the patella in the NWB and WB knee extended positions in individuals with PFP indicates the role of both passive and active structures as contributors to PFP. Increased superior shift of the patella may prevent proper engagement of the patella into the trochlea in the early range of knee flexion.
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Comparison of Cardiac Index, Inferior Vena Cava Collapsibility Index, Body Weight and Clinical Judgement as Indicators of Volume Status in Endurance Athletes

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Objective: Does change in body weight (BM), inferior vena cava ultrasound collapsibility index (IVC) and clinical judgment correlate with cardiac index (CI) and stroke volume (SV) in athletes before and after an endurance event?
Study Design: Descriptive, observational and prospective field study conducted in August 2017 during the Mont-Tremblant Ironman.
Subjects: Ninety-three adult Canadian athletes competing in the event completed the initial consent and pre-event measures. Seventy-two athletes presented after the race and 56 athletes completed all post-event measures.
Observation Technique: BM, CI and SV were measured at time of recruitment. Volunteers presented to the medical tent immediately after finishing the event for repeat BM, CI, SV and IVC measurement. Clinical judgement of hydration status was done by a physician blinded to all other measurements.
Outcome Measures: Linear regression analysis using post-event CI and SV as dependent variables and change in BM (ΔBM), IVC and clinical judgement as independent variables. Results were adjusted for pre-event CI, age, gender, hours of training per week, number of years training and finish time.
Results: Mean CI pre-event was 3.47 ($L{\cdot}min^{-1}{\cdot}m^{-2}$) [standard deviation (SD) 0.54] and post-event was 3.20 ($L{\cdot}min^{-1}{\cdot}m^{-2}$) (SD 0.53). Mean IVC was 39.22 (SD 22.4) and mean ΔBM was -3% (SD 2). The IVC correlated significantly with post-event CI after adjustment: mean increase of 0.00741 (95% confidence interval 0.00089-0.01393; $P = 0.027$). ΔBM and clinical judgement did not correlate significantly with post-event CI. SV did not correlate with IVC, ΔBM or clinical judgement.
Conclusions: There is evidence to suggest that IVC collapsibility index is predictive of post-endurance event CI after adjusting for pre-endurance event CI, age, gender, race time, training years and training hours per week.
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Systematic Review of Quadriceps Muscle Injuries in Athletes

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Objective: Quadriceps muscle injuries are a common injury in elite soccer players making up to 19% of all muscle injuries[6]. Risk factors include prior injury (quad/hamstring), kicking leg, preseason, shorter players, low rainfall in prior week, decreased quad and hamstring flexibility at preseason testing. This paper is a review of the existing literature to improve our current understanding of grading, imaging and return to play after indirect quadriceps muscle injuries with exclusion of quadriceps tendon and patellar tendon injuries.
Data Sources: Using the PRISMA guidelines for abstract a systematic review of pubmed, EMBASE and search of subsequent references from these articles was conducted on July 10, 2017 using the following terms: thigh injuries, rectus femoris injuries, and quadriceps injuries. The following injuries were excluded distal quadriceps tendon injuries, patellar tendon injuries, and articles unrelated to rectus femoris/quadriceps muscle injuries in athletes.

Main Results: The search included 61 articles of which 6 studies included information specifically relating to grading systems with imaging of quadriceps muscle injuries, and/or return to play after a quadriceps muscle injury. There were 4 different grading systems described in 5 different papers [1,2,3,4,6]. Imaging of quadriceps muscle injuries was reported in 5 studies[1,2,3,4,5] and included MRI, US or a combination of one or the other. Three studies specifically referred to the time to return to play after a quadriceps muscle injury[1,2,3]. Two of these used Peetron's grading classification had return to plays with the following ranges: Grade 1 – 12 to 27.7 days, Grade 2 – 22 to 46.3 days, and Grade 3 – 67 days. One study described MRI findings of 7 degloving injuries to proximal rectus femoris with a mean return to play of 38.7 days (range 28-58).[3]

Conclusions: Due to the vast heterogeneity in injury description, classification and grading it was not possible to compare return to play times following quadriceps muscle injuries from the reviewed studies.

Peetron's Classification Grade 1 – 3 was the most used grading system for quadriceps muscle injuries. Return to play after indirect quadriceps muscle injuries although multifactorial ranged from 12 to 67 days.