

# Canadian Academy of Sport and Exercise Medicine Sport and Exercise Medicine on the Western Edge 2013 CASEM Annual Scientific Conference April 24-27, 2013 Whistler, British Columbia, Canada

## PODIUM PRESENTATIONS

### Consistency of Reported Outcomes Following Arthroscopic Management of Femoroacetabular Impingement: A Systematic Review

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**Objective:** Femoroacetabular impingement (FAI) is increasingly being recognized as a cause of hip pain in the prearthritic patient. Outcomes following arthroscopic surgery for FAI are reported to be favorable; however, the consistency in outcome reporting has not been systematically documented. This systematic review evaluates consistency of the reporting of clinical and radiographic outcomes following arthroscopic management of FAI.

**Study Design:** Systematic review.

**Subjects:** Not applicable, systematic review.

**Observation Technique:** Two databases (MEDLINE and EMBASE) were screened for clinical studies involving the arthroscopic management of FAI. A full-text review of eligible studies was conducted, and the references were searched. Inclusion and exclusion criteria were applied to the searched studies and a quality assessment was completed for included studies.

**Outcome Measures:** Reported clinical and radiographic outcomes following arthroscopic treatment of FAI.

**Results:** We identified 29 eligible studies involving 2816 patients. There was a lack of consensus with regards to reported outcomes (clinical and radiographic) following arthroscopic treatment of FAI. Clinical outcomes reported included the Harris Hip Score (45%) and the Non Arthritic Hip Scale (28%), Range Of Motion (34%), Pain Scores (24%), and patient satisfaction (28%). The most commonly reported radiographic outcomes included the alpha angle (38%), head-neck offset (14%), and degenerative changes (21%).

**Conclusions:** There is significant variation in reported clinical and radiographic outcomes following arthroscopic treatment of FAI. This study highlights the need for consistent outcome reporting following arthroscopic FAI surgery. Future research should explore what combination of clinical and radiographic outcomes should be best used to determine successful FAI management.

### Kinesiology Tape Versus NSAIDs as an Adjuvant Therapy to Exercise for the Treatment of Shoulder Impingement Syndrome

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**Objective:** To determine if kinesiology tape is as effective as nonsteroidal anti-inflammatory drugs (NSAIDs) when used as an adjunctive therapy to exercise at reducing pain and improving function in patients with rotator cuff impingement.

**Study Design:** Prospective, single-blind, randomized control trial.

**Subjects:** One hundred subjects (average age, 48 ± 12.3; 61 males, 39 females) with a diagnosis of subacromial impingement syndrome.

**Observation Technique:** Subjects were randomly assigned to 1 of 3 treatment groups: taping and exercise (n = 33), NSAIDs and exercise (n = 29), or exercise only (n = 38). All patients completed the same 2-week (4 sessions) exercise program guided by a registered physiotherapist.

**Outcome Measures:** Pain at rest and pain with arm elevation were assessed using a Numeric Pain Rating Scale. Subjective and objective shoulder function were assessed using the Simple Shoulder Test (SST) and the Constant Score. A research assistant, blinded to treatment allocation, completed pre-treatment and posttreatment assessments.

**Results:** A significant reduction in pain with arm elevation and improvement in SST and Constant Scores were observed in the taping and exercise group (1.2±2.5, 1.6±2.2, 7.8±8.1, respectively; *P* < 0.05), the NSAIDs and exercise group (2.1±2.4, 1.5±2.7, 11.0±11.7; respectively; *P* < 0.05), and the exercise only group (1.3±2.6, 1.4±2.2, 6.3±10.9, respectively; *P* < 0.05). Between-group differences were not statistically significant. Both the taping and exercise group and the NSAIDs and exercise group showed a significant improvement in activities of daily living (0.8±1.2, 1.0±1.6, respectively; *P* < 0.05) and functional arm level (1.6±2.2, 0.8±2.0, respectively; *P* < 0.05) compared to the exercise only group. Patients were more compliant with the kinesiology tape (100%) than the NSAIDs treatment regimen (84%).

**Conclusions:** As an adjuvant therapy to exercise, the use of kinesiology tape is as effective as NSAIDs at reducing shoulder pain and improving function in patients with subacromial shoulder impingement. The use of kinesiology tape among patients appears to be well tolerated. Kinesiology tape may prove to be a safer alternative to NSAIDs in supporting the conservative treatment of shoulder impingement pain and dysfunction.

### Individuals With Mild to Moderate Bilateral Knee Osteoarthritis Exhibit Between-Limb Kinematic Asymmetry During Gait

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**Objective:** To compare between-limb lower-limb kinematic asymmetries during gait in individuals with unilateral and bilateral knee osteoarthritis (OA) and controls.

**Study Design:** Cross-sectional.

**Subjects:** Thirty-six community-dwelling individuals with mild to moderate clinically and radiographically diagnosed knee osteoarthritis (males=10, Age=53.86 (SD, 7.48), BMI = 25.47 (2.36) kg/m<sup>2</sup>, KL grade <3) and 18 healthy controls

(males = 5, Age = 52.53 (10.81) years, BMI = 24.34 (2.66) kg/m<sup>2</sup>). Knee OA participants were divided into those with unilateral and bilateral symptoms. Mechanical alignment was similar between groups. The study limbs of control participants were matched to the symptomatic limbs of their corresponding unilateral knee OA participant.

**Observation Technique:** Three-dimensional coordinates of the pelvis, hips, and knees were captured during level walking at 1.1 m/s.

**Outcome Measures:** Peak angles and velocities of the knee and hip at initial contact and during stance were compared between groups (unilateral, bilateral, and healthy). Frontal plane pelvic drop, average toe out, and stride length were also compared.

**Results:** Significant group\*asymmetry interactions were present for knee flexion at initial contact ( $P = 0.01$ ) and peak hip internal rotation velocity ( $P = 0.023$ ). In both instances the individuals with bilateral knee OA exhibited moderate asymmetry [Effect Size (ES) = 0.67 and 0.63]. The bilateral group also exhibited small trends towards asymmetry for hip adduction at initial contact (ES = 0.38) and knee adduction during stance (ES = 0.44). There were no differences between individuals with unilateral knee OA and controls.

**Conclusions:** Between-limb kinematic asymmetries were more prevalent in those with bilateral disease, occurring at the hip and the knee. Individuals with unilateral disease were not only symmetrical between-limbs, the magnitude of joint angles were similar to that of healthy controls. These findings suggest that individuals with unilateral disease maintain kinematic symmetry further into the knee OA process than those with bilateral disease. Individuals with bilateral knee osteoarthritis may benefit from early implementation of rehabilitation programs targeted at restoring symmetry during gait.

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### The Infrastructure of Sport and Exercise Medicine in Canada

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**Objective:** To evaluate the infrastructure of Canadian sport and exercise medicine (SEM).

**Study Design:** Mixed-method study of a quantitative cross-sectional survey and qualitative focus group and individual interviews.

**Subjects:** Canadian Academy of Sport and Exercise Medicine (CASEM) physicians.

**Intervention:** The quantitative survey was distributed to CASEM diploma holders in the CASEM database via e-mail. Nonresponders and those without a valid e-mail address were sent a paper version. The qualitative interviews were primarily conducted in person or over the phone. Interviews were audio-recorded and transcribed.

**Intervention:** The quantitative survey examined physician demographic, practice, teaching, and research profiles. Qualitative interviews examined the promoters of, and barriers to, involvement in teaching, event coverage and research, and opinions of the role of SEM organizational bodies.

**Results:** Survey response rate was 55% (n = 246/451). The geographic distribution of SEM physicians approximates the Canadian population distribution. The majority of respondents act as consultants and dedicate the majority of their practice to SEM. Eighty-six percent of respondents teach SEM and teaching is primarily done in a clinical setting. The postsecondary affiliation of a physician and the population size of where a physician practises predict the amount of time that a physician dedicates to clinical teaching and research. Approximately half of the respondents provide event coverage in a typical week and nearly one-third of respondents had conducted research within the past 5 years. Various forms of fulfillment are the main promoters for teaching, event coverage, and research. The lack of financial compensation

and time are the main barriers to these activities and appear to be intricately linked. Interviewees appreciated SEM organizations for networking and educational opportunities.

**Conclusions:** The current SEM physician demographics, geographic distribution, practice profiles, and support from other health professionals indicate that SEM has sufficient infrastructure to support a focused practice. The barriers to SEM teaching, event coverage, and research will need to be addressed to progress Canadian SEM. Professional SEM organizations are managing SEM physician activities and are viewed as leaders to promote SEM as a profession.

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### Morphological Changes of Graft Donor Semi-tendinosus and Gracilis After ACL Reconstruction

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**Objective:** To evaluate change in muscle morphology of semi-tendinosus (ST) and gracilis (G) graft donor muscles used during ACL reconstruction.

**Study Design:** Cohort study.

**Subjects:** Longitudinal assessment was performed on 20 adults undergoing ACL reconstruction.

**Intervention:** ACL reconstruction on the deficient leg and no reconstruction on the contralateral leg.

**Outcome Measures:** Bilateral lower extremity MRI was obtained at 2 weeks pre- and 12 months postsurgery from the ischial tuberosity to 10 cm proximal to the lateral knee joint line with 5.0 mm slice-thickness and a 1.5 mm interslice gap (repetition time 660 ms, echo time 15 ms). Cross-sectional areas of ST and G were computed for each slice (minimum 25 slices per participant) using a custom algorithm in MatLab (Mathworks, Natick, Massachusetts). Differences in muscle areas within the harvested limb were examined between time points, as well as a between limbs at 12 months.

**Results:** Mean (SD) age of the participants was 29.2 (7.1) years with 15 males and 5 females. From pre- to 12 months postsurgery, there was a significant reduction ( $P < 0.001$ ) in muscle area of the proximal muscle belly in both graft donor ST and G, but no reduction in muscle area in the corresponding contralateral unharvested muscles. At 12 months, the graft donor muscle areas were significantly reduced ( $P < 0.001$ ) by 79 (8.2)% and 49 (5.0)% for ST and G, respectively, relative to the contralateral limb. Complete atrophy of the graft donor muscle was observed in 29% of participants for ST and no participants for G. In addition, there was a mean proximal shift of 57 (28.8) cm for ST and 42 (23.2) cm for G. At 12 months, there were no participants that maintained muscle cross section within 5% of the presurgical values or within 5% of the contralateral limb.

**Conclusions:** Marked or complete atrophy of graft donor STG muscle has implications for functional outcome. A resultant change in the line of action at the knee and the potential shift from bi-articular to uni-articular force generation are inevitable. Approach to muscle harvest in surgery and/or greater emphasis on hamstring rehabilitation may mediate this consequence and should be further investigated.

### ACL-QOL Scores Following Anatomic ACL Reconstruction: The Influence of Postoperative Laxity on This Disease-Specific Patient-Reported Outcome Measure

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**Objective:** The Anterior Cruciate Ligament Quality of Life (ACL-QOL) is a patient-reported outcome measure that was developed and validated for chronic ACL deficiency. It is currently in the process of being validated for ACL reconstruction surgery. Despite a technically successful surgery, some patients

will continue to have objective knee laxity following ACL reconstruction. The importance of postoperative laxity is of an unknown clinical significance. The objective of this study was to compare ACL-QOL scores at 12 months after a primary anatomic hamstring autograft ACL reconstruction between patients with objective ACL laxity and patients with no postoperative ACL laxity.

**Study Design:** A prospective cohort study design in a high-volume sport medicine surgical practice.

**Subjects:** Three hundred sixty-nine patients who received a unilateral primary hamstring autograft anatomic ACL reconstruction.

**Outcome Measures:** Postoperative ACL laxity assessment using the Lachman and Pivot-shift tests was performed. Patients completed the ACL-QOL at the 1-year postoperative appointment. A comparison of patients with no ACL laxity, laxity in either the Lachman or Pivot shift tests, and laxity with both tests was then performed to assess whether the 3 groups of patients demonstrated differences in ACL-QOL scores at 1 year postoperatively.

**Results:** Fifty-three of 369 patients (14.4%) demonstrated a positive Lachman and/or Pivot-shift test 1 year after ACL reconstruction. Seven patients (1.9%) had ruptured their ACL graft and were determined to be gross failures at 1 year postsurgery. At 1 year postoperatively, ACL-QOL scores were available for 283 patients (77%). The average ACL-QOL score for patients with no ACL laxity ( $n = 229$ ) was 71.63, for patients with any degree of ACL laxity ( $n = 46$ ) the mean score was 65.76, and for patients with positive Lachman and Pivot-shift tests ( $n = 12$ ) the score was 58.38.

**Conclusions:** The incidence of objective laxity following ACL reconstruction is consistent with previous studies. Patients with measurable ACL graft laxity 1 year postoperatively demonstrate a trend towards a lower mean ACL-QOL. Further study is required to identify other factors that may be correlated with the development of laxity, as well as to assess whether laxity after anatomic ACL reconstruction influences patient functional testing.

### A Randomized Clinical Trial Comparing Patellar Tendon, Hamstring Tendon, and Double-Bundle ACL Reconstructions: Patient-Reported and Clinical Outcomes at a Minimal 2-Year Follow-Up

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**Objective:** To compare anatomic patellar, quadruple hamstring, and double-bundle hamstring tendon autografts for Anterior Cruciate Ligament (ACL) reconstruction, by measuring patient-reported disease-specific quality of life outcome at a minimum 2 years postoperatively.

**Study Design:** Prospective, double-blinded, randomized clinical trial.

**Subjects:** Three hundred thirty patients (14-50 years old; 183 males) with isolated ACL deficiency.

**Intervention:** Intraoperative computer-generated randomization to ACL reconstruction with: 1) Patellar Tendon, 2) Quadruple-stranded Hamstring Tendon, or 3) Double-Bundle using hamstring tendons. Patients and the independent trained evaluator were blinded to treatment allocation.

**Outcome Measures:** Outcomes were measured at baseline, 3 and 6 months, and 1 and 2 years postoperatively. **Primary:** Anterior Cruciate Ligament Quality of Life (ACL-QOL). **Secondary:** IKDC subjective and objective scores, KT arthrometer (134N), pivot shift, range of motion, Tegner activity, Cincinnati Occupational Scale, and proportions of traumatic ruptures and atraumatic graft failures. Blinding effectiveness was measured as the proportion of correct guesses of graft type by the patients and evaluator.

**Results:** There was no difference in baseline characteristics between groups. Three hundred twenty-two completed minimum 2-year follow-up. There was no difference in mean ACL-QOL score ( $P = 0.591$ ): PT = 84.6 (SD, 16.6; 95% CI, 81.4–87.8); HT = 82.5 (SD, 17.7; 95% CI, 79.2–85.9); DB = 82.4 (SD, 17.5; 95% CI, 79.1–85.7). There were no differences between groups in the proportions of patients with a pivot shift  $\geq$  grade 2 (PT=14%; HT=18%; DB=19%;  $P = 0.573$ ), IKDC Normal/Nearly Normal knees (PT = 78%; HT =

73%; DB = 71%), and  $\leq 5$ mm side-to-side difference (SSD) on the KT arthrometer (PT = 93%; HT = 88%; DB = 85%;  $P = 0.173$ ). Mean KT SSD measurements (PT = 1.86 mm; HT = 2.97 mm; DB = 2.65 mm) were statistically significant between the PT and HT groups ( $P = 0.02$ ) and between the PT and DB groups ( $P = 0.444$ ). The remaining secondary outcomes were not statistically different. Proportions of traumatic reinjuries: (PT = 3/110; HT = 12/110; DB = 11/110;  $P = 0.047$ ), and atraumatic graft “failures”: PT = 16; HT = 17; DB = 20 ( $P = 0.747$ ). Patients and the evaluator correctly guessed the allocated graft type 51% and 46% of the time, respectively.

**Conclusions:** At 2 years, there was no difference in disease-specific quality of life outcome or IKDC grades between the 3 techniques for ACL reconstruction. Based on mean KT measurements, PT reconstructions had significantly lower side-to-side differences. More traumatic ruptures occurred in the HT and DB groups, but similar atraumatic graft “failures” between groups. Blinding of the patients and evaluator was achieved.

### A Detailed Prospective and Blinded Analysis of Complications/Adverse Events in Patients Having ACL Reconstruction

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**Objective:** To describe all complications/adverse events following ACL reconstructive surgery.

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

**Subjects:** Three hundred thirty patients (14-50 years old; 183 males) with isolated ACL deficiency.

**Intervention:** Patients were equally distributed to: patellar tendon (PT), quadruple-stranded hamstring (HT), and double-bundle hamstring (DB) autograft ACL reconstruction.

**Outcome Measures:** Adverse events were patient-reported, documented, and diagnoses confirmed. Patients and the independent assessor were blinded to allocation.

**Results:** Three hundred twenty-two patients were available at 2 years. One life-threatening pulmonary embolism (at 2 weeks postop) was successfully treated with anticoagulation and an IVC filter (0.3%). One case of septic arthritis was treated with arthroscopic washout and IV antibiotics, resulting in successful graft preservation (0.3%). Forty-five patients (13.6%) required repeat surgery, including 62 separate operations: PT = 9 (8.2%), HT = 20 (18.2%), DB = 16 (14.5%). This was not statistically significant. Seventeen patients (5.1%) suffered a rupture of their ACL reconstruction; 16 required ACL revision surgery: 13 had 2-stage revisions, 3 had 1-stage revisions, and 1 refused revision. Revisions were more likely required in the HT and DB groups: PT = 3, HT = 7, DB = 7.

Repeat arthroscopy was performed for meniscal (3.9%;  $n = 13$ ) and chondral pathology (0.6%;  $n = 2$ ) to identify and manage a partial graft rupture (0.6%;  $n = 2$ ). Nine patients required arthroscopic treatment for graft hypertrophy/Cyclops lesions/arthrofibrosis (2.7%). One patient required repeat surgery for wound dehiscence. Thirty patients out of 305 on examination at 2 years postop reported moderate to severe kneeling pain (9.8%; PT = 17, HT = 9, DB = 4). Other complications: hamstring strain (5.5%; HT = 6, DB = 12); traumatic hamstring tendon rupture (0.3%; PT = 1); contralateral ACL rupture (5.1%;  $n = 17$ ); DVT requiring anticoagulant therapy ( $n = 1$ ); minor wound infections/cellulitis treated with oral antibiotics ( $n = 7$ ); tibial periostitis treated with NSAIDs ( $n = 5$ ); infrapatellar branch saphenous nerve injury treated locally ( $n = 8$ ; 1 with significant dysesthesia; unresolved); tibial fixation screw pain ( $n = 1$ ), and wound dehiscence requiring local treatment ( $n = 2$ ).

**Conclusions:** Overall, 13% of patients required a reoperation after ACL reconstruction. Revisions were required in 5% of patients, with a greater chance in HT or DB reconstructions. Contralateral ACL injuries occurred in 4.5%. Hamstring injury was more common in the HT and DB groups. Nearly 10% of patients had kneeling pain, which was higher in the PT group. Stiffness-related problems requiring surgical treatment occurred in 3% of patients. Major complications were rare.

## A Multicenter Randomized Clinical Trial of Nonoperative Versus Operative Treatment of Acute Acromioclavicular Joint Dislocation

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**Objective:** The optimal treatment for acute dislocation of the acromioclavicular (AC) joint remains unclear. Previous trials did not reveal any significant differences between surgical repair and nonoperative treatment. However, these studies used inferior surgical techniques and surgeon-based or radiographic outcome measures. We performed a clinical trial of operative versus nonoperative treatment of acute AC joint dislocations utilizing modern surgical fixation and patient-based outcomes.

**Study Design:** Multicenter, prospective randomized clinical trial.

**Subjects:** Eighty-three consecutive eligible patients, presenting to the Orthopaedic surgeons at 9 emergency departments, with acute (<3 weeks old) complete (Grade III, IV, V) dislocations of the AC joint.

**Intervention:** We compared operative repair with hook plate fixation versus nonoperative treatment.

**Outcome Measures:** The primary outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 1 year postinjury. Assessment also included a clinical assessment, the Constant score, the SF-36 score, and a radiographic evaluation at 6 weeks, and at 3, 6, 12, and 24 months

**Results:** Eighty-three patients were randomized (operative repair, 40; nonoperative treatment, 43). There were no demographic differences between the 2 groups, and the mechanisms of injury were similar between the 2 groups. DASH scores (a lower score is better) were significantly better in the nonoperative group at 6 weeks (operative, 46; nonoperative, 32;  $P = 0.0109$ ) and 3 months (operative, 29; nonoperative, 16;  $P = 0.0247$ ). There were no significant differences between the groups at 6 months (operative, 14; nonoperative, 12;  $P = 0.443$ ), and 1 (operative, 9; nonoperative = 6,  $P = 0.834$ ), or 2 (operative, 4; nonoperative, 6;  $P = 0.798$ ) years postinjury. Similar values were seen for Constant scores. Although radiographic results were better in the operative group, the reoperation rate was significantly lower in the nonoperative group ( $P < 0.05$ ).

**Conclusions:** Hook plate fixation is not superior to nonoperative treatment for the treatment of acute, complete dislocations of the AC joint. The nonoperative group had better early scores, although both groups improved from a significant level of initial disability to a good or excellent result (mean DASH score 4 to 6, mean Constant score 93) at 2 years.

## Baseline Self-Report of Postconcussion Symptoms in Varsity Athletes: A Comparison of Standardized Assessment Paradigms Using SCAT2 and ImPACT

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**Objective:** To examine and compare varsity athletes' self-report of symptoms (the Post-Concussion Symptom Score or PCSS), from 2 commonly utilized tools: the paper version of the Sideline Concussion Assessment Tool 2 (SCAT2) and the computerized neurocognitive test Immediate Post-Concussion Assessment and Cognitive Test (ImPACT).

**Study Design:** Retrospective, cross-sectional.

**Subjects:** Varsity athletes in contact and collision sports (hockey, football, rugby, soccer, basketball, and wrestling) at the University of Alberta: 356

athletes (218 males, 138 females). Mean age of the athletes was 20.02 years (range, 16-28 years of age).

**Intervention:** Athletes completed preseason questionnaires and baseline concussion screening using both SCAT2 and ImPACT. Testing was conducted over 3 varsity seasons, from 2010-2011 through 2012-2013.

**Outcome Measures:** Both individual symptom scores and the Total Symptom Score (TSS) on the 2 PCSS scales were compared.

**Results:** Using  $t$  tests, 17 "matched" symptoms and Total Symptom Score (TSS) were analyzed. There were statistically significant differences ( $P < 0.05$ ) on 10 of these self-reported symptoms (headache, fatigue, trouble falling asleep, drowsiness, sensitivity to light, irritability, feeling more emotional, difficulty concentrating, difficulty remembering, and visual problems) and on the TSS. Mean scores from ImPACT tests were higher for 9 of these symptoms and for the TSS. An interaction was statistically significant between gender and test group for "feeling more emotional" and "difficulty concentrating". On ImPACT, females reported more often than males that they were "feeling more emotional"; but the reverse was seen on the SCAT2, with males reporting this symptom less often. Males reported having "difficulty concentrating" less frequently than females on both tests.

**Conclusions:** In this study, athletes' self-report of postconcussion symptoms differed, depending on the type of concussion evaluation tool used and the mode of administration. When performing baseline, postinjury and return-to-play assessments, sport medicine practitioners should ensure these ancillary tests are given in the same form and under the same conditions. However, these are still only tools, and in evaluation of athletes with concussions, serial clinical examinations should be performed by an appropriately trained medical professional.

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## Comparing Reported Concussion History Between a Paper-based Questionnaire and ImPACT in a Sample of Elite Youth Ice Hockey Players

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**Objective:** To examine differences in concussion history, attention problems, and learning problems reported by elite youth ice hockey players using a paper-based questionnaire compared to ImPACT.

**Study Design:** Cross-sectional.

**Subjects:** The sample included 714 (601 male, 113 female) Bantam (ages 12-14) and Midget (ages 15-17) ice hockey players from the most elite divisions of play (AA, AAA) in Calgary and Edmonton.

**Observation Technique:** Players completed a take-home preseason questionnaire (PSQ) with a parent/guardian and a baseline ImPACT test by themselves at the beginning of the 2011-2012 hockey season.

**Outcome Measures:** Outcomes included the number of previous concussions and the presence of attention or learning problems reported on the PSQ and ImPACT test.

**Results:** In 21.1% (95% CI, 18.1-24.1) of cases, there was disagreement between PSQ and ImPACT in terms of the number of previous concussions reported. Compared to the PSQ, ImPACT indicated fewer concussions in 9.6% (95% CI, 7.4-11.8) of cases and more concussions in 11.4% (95% CI, 9.1-13.8) of cases. Disagreement was highest for those reporting 1 (41.3% of cases) or 2 (38.7% of cases) previous concussions. Bantam players were less likely to have agreement in concussion history between the PSQ and ImPACT than Midget players, adjusting for cluster by team (OR = 0.53; 95% CI, 0.35-0.80). There was no association between sex and agreement

(males compared to females: OR = 0.85; 95% CI, 0.45-1.59). Of those reporting an attention problem on the PSQ, 85.7% also reported a problem on ImPACT. Conversely, 90.5% of those who reported a learning problem on the PSQ did not report it on ImPACT.

**Conclusions:** For 1 in 5 players, reported concussion history differed between PSQ and ImPACT, and there was a bias associated with reporting learning problems. The method of obtaining medical history may therefore affect baseline and postconcussion evaluations.

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### Effect of Flare Reaction to Intra-Articular Injection on Cartilage Lubricating Ability of Human Synovial Fluid

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**Objective:** To 1) quantify proteoglycan 4 (PRG4) and hyaluronan (HA) content in osteoarthritic (OA) synovial fluid (SF) after flare reaction to intra-articular (IA) injection; and 2) assess the cartilage boundary lubricating ability of PRG4-deficient flare-SF, with and without supplementation with PRG4±HA.

**Study Design:** Retrospective case-control.

**Subjects:** Fourteen flare-SF samples from knee OA patients requiring aspiration ≤11 days after IA injection (HA or corticosteroid) were obtained. Four samples were identified as PRG4-deficient compared to normal SF (cadaveric) and selected for boundary lubricating ability tests; the 4 selected samples were flares after IA HA. Two normal SF samples were used as positive controls for boundary lubricating ability tests.

**Intervention:** Flare-SF deficient in PRG4 was supplemented with normal concentrations of PRG4 (450 µg/mL) and PRG4 (450 µg/mL)+HA (1.0 mg/mL). Boundary lubricating ability was compared to normal SF.

**Outcome Measures:** HA and PRG4 concentration were measured using sandwich enzyme linked immunosorbent assays. HA molecular weight distribution was determined using 1% agarose gel electrophoresis. Cartilage boundary lubricating ability of PRG4-deficient flare-SF, supplemented flare-SF, and normal SF was measured. Static and kinetic friction coefficients were calculated. ANOVA was used to assess differences in PRG4 and HA composition and effects of lubricants.

**Results:** Flare-SF samples contained PRG4 and HA concentrations ranging from below normal to super-physiological. HA concentration in the PRG4-deficient flare-SF selected for friction testing did not differ from normal ( $P = 0.5$ ), while HA MW was shifted slightly towards the smaller size range ( $P < 0.05$  for 0.5-1.1MDa range only). The kinetic friction coefficient in PRG4-deficient flare-SF was not altered compared to normal, and no changes were observed with PRG4 or PRG4+HA supplementation ( $P = 0.77-1.0$ ).

**Conclusions:** Some OA SF may exhibit altered lubricant composition (decreased PRG4) after flare reaction to IA injection, but can still retain normal boundary lubricating ability. An HA distribution similar to that of normal SF, as observed here, could contribute to the normal lubricating ability observed. The physiological implications, if any, of SF PRG4 deficiency after flare reaction to IA treatment need to be investigated further.

### POSTER PRESENTATIONS

#### Results of the PeReception of femOroaCetabular impingement by Surgeons Survey (PROCESS)

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**Objective:** Currently, there is a lack of high-level evidence addressing the variety of treatment options available for patients diagnosed with Femoroacetabular Impingement (FAI). Our objective was to determine the current state of practice for FAI in Canada.

**Study Design:** Survey study.

**Subjects:** We surveyed the membership of the Canadian Orthopaedic Association (COA) through e-mail and mail in both French and English. All responses were recorded onto a secure Web-based server.

**Observation Technique:** We developed and pretested a questionnaire to address the current state of knowledge among orthopaedic surgeons regarding FAI treatment using a focus group of experts, reviewing prior surveys, and reviewing online guidelines addressing surgical interventions for FAI.

**Outcome Measure:** An investigator-generated survey to determine the current state of practice for FAI in Canada.

**Results:** Two hundred two surveys were obtained (20% response rate), of which 74.3% of respondents manage patients under age 40 with hip pain. Most surgeons (62%) considered failure of nonoperative management as the most important indication for the surgical management of FAI, usually by treating both bony and soft tissue damage (54.4%). The majority of surgeons were unsure of the existence of evidence supporting the best clinical test for FAI, the use of a diagnostic intra-articular injection for diagnosis of FAI, and for nonoperative management of FAI. One in 4 respondents supported a sham surgery (24.8%) control arm for a trial evaluating the impact of surgical intervention for FAI.

**Conclusions:** Given the lack of high quality evidence for best diagnosis and treatment practices for FAI, a randomized controlled trial, preferably placebo-controlled, for the surgical management of these patients is needed.

#### Normative Values and Within-Session Reliability of Sonographic Measures of the Abdominal, Lumbar Paravertebral, Lateral Hip, and Vastus Medialis Obliquus Muscles in Adolescent Female Soccer Players

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**Objective:** To establish normative baseline values and evaluate within-session intra-rater reliability of sonographic measures of the abdominal, lumbar paravertebral, lateral hip, and knee musculature of adolescent female soccer players.

**Study Design:** Single-group repeated-measures reliability study.

**Subjects:** Twenty-nine adolescent female soccer players (aged 14-17) recruited from 3 teams that participated in a FIFA11+ implementation strategies study during the 2011 season.

**Observation Technique:** B-mode sonography was used to gather bilateral measures including: resting Rectus Abdominis, External Oblique, Internal Oblique, Transversus Abdominis, Lumbar Multifidus, Gluteus Medius (GMd), Gluteus Minimus (GMn), and Vastus Medialis Obliquus (VMO) muscle thickness; VMO and inter-recti distance width; and thickness change of the abdominal parameters during an Active Straight Leg Raise Test, and GMd and GMn during a hip abduction task during 1 session.

**Outcome Measures:** Mean and 95% CI for resting, contracted, and change during contraction (where applicable) of all parameters were calculated. Intra-class correlation coefficients (ICC) with 95% CI were used to estimate reliability, Standard Error of Measurement (SEM) was used to estimate measurement precision, and Minimal Detectable Change (MDC) was calculated to provide an estimate of the minimal change required to be 95% confident that a true change has occurred.

**Results:** By using the mean of 3 measures, intra-rater reliability point estimates (ICC<sub>3,3</sub>) ranged between 0.88 to 0.99, 0.83 to 0.99, and 0.50 to 0.88 for resting, contracted, and change during contraction, respectively. Precision values (SEM) ranged between 0.1 to 1.4mm and MDC between 0.4 to 4.0mm across parameters measured. Baseline values for the abdominal wall and lumbar multifidus, as well as the percent contribution of each of the abdominal muscles to the total abdominal wall, were consistent with previous studies undertaken on adult females.

**Conclusions:** To our knowledge this study provides the first characterization of these muscles in an adolescent female sporting population. Sonographic measurements of the abdominal, lumbar paravertebral, lateral hip, and knee musculature of adolescent female soccer players at rest and during contraction, when based on the mean of 3 measurements, are highly reliable when taken by a single examiner. Further, measurements of changes of these parameters during contraction are moderately reliable.

### The Use of Early Immobilization in the Management of Acute Soft-Tissue Injuries of the Knee - The Results of a Survey of Emergency Physicians, Sports Medicine Physicians, and Orthopedic Surgeons

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**Objective:** This study explored the opinions and reported practice patterns of emergency physicians (EP), sports medicine physicians (SMP), and orthopedic surgeons (OS) with regards to the use of early immobilization in the management of acute soft tissue knee injuries.

**Study Design:** Web-based survey.

**Subjects:** Fifty-eight EP, 15 SMP, and 39 OS in the Edmonton region.

**Observation Technique:** A Web-based survey was developed using standardized methodology and sent to all EP, SMP, and OS in the Edmonton region. The survey was designed to evaluate patient and physician factors that may be associated with use of early immobilization. To test for differences in rates of knee immobilization prescription, data was analyzed using a chi-squared test.

**Results:** The overall response rate was 39% (44/112) and was 29% (17/58), 47% (7/15), and 51% (20/39) for EP, SMP, and OS, respectively. All of the EP and none of the SMP or OS reported seeing patients within 24 hours of the injury while 60% of SMP and 46% of OS reported seeing patients within 7 days ( $P < 0.001$ ). For suspected ACL injury, 77% of EP, 29% of SMP, and 25% of OS said they would immobilize ( $P = 0.005$ ). In cases of suspected meniscus injury, 50% of EP indicated they would prescribe immobilization, whereas 0% of SMP and 5% of OS would immobilize ( $P = 0.002$ ). For LCL injury, 53% of EP, 0% of SMP, and 32% of OS would immobilize ( $P = 0.04$ ). All of the respondents would prescribe immobilization for a grossly unstable knee. Pain relief and protection of soft tissues was selected as the first or second reason to immobilize by 72% of respondents. Conversely, concern for motion loss was selected as the first or second reason not to immobilize by 66% of respondents.

**Conclusions:** In the Edmonton region, EP seem more likely to prescribe immobilization for certain acute soft tissue knee injuries than SMP and OS. EP are seeing patients earlier than SMP and OS, which could account for part of this difference. Efforts to reduce practice variability may include knowledge translation efforts such as the development of an evidence-based guideline for the use of knee immobilization after acute soft tissue injury.

### Characterization of Physical Activity in ACL Reconstruction Surgery Patients

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**Objective:** To characterize physical activity (PA) over a 12-month timeframe (pre-ACL reconstruction surgery through rehabilitation), and compare to age-matched Canadian population normative data.

**Study Design:** Prospective case series.

**Subjects:** Longitudinal assessment was performed on 20 adults awaiting ACL reconstruction.

**Observation Technique:** PA was assessed over 7 days (3 sec epochs) using a tri-axial accelerometer (GTX3, Actigraph, Pensacola, Florida) at 2 weeks pre-, and 2 weeks, and 6 and 12 months postsurgery.

**Outcome Measures:** Average daily step counts were compared to age-matched population data using a single sample *t* test. A 'clinically relevant change' of 2000 steps per day was adopted based upon Tudor-Locke (2004).

**Results:** Mean (SD) age was 29.2 (7.1) years, 5 female and 15 male. Average BMI was 26.8 (3.7), not statistically different from age-matched normative data (Colley et al, 2011). Mean number of days the accelerometer was worn was 5.9 (1.4) at presurgery, 5.7 (1.7) at 2 weeks, 5.7 (1.2) at 6 months, and 5.7 (1.4) at 12 months postsurgery. Mean wear time exceeded 13.0 (1.7) hours per day. Mean presurgical daily step count was 7205 (2384.3). Postsurgery mean daily step counts were: 2 weeks 5595 (2319.8); 6 months 7163 (2520.8); 12 months 8876 (3609.4). The increase of 1671 steps from pre to 12 months was not statistically significant and did not meet the clinically relevant threshold. There was a significant reduction in steps from pre- to immediate postsurgery ( $P < 0.05$ ). Presurgery step count was significantly reduced (-2721 steps;  $P < 0.001$ ) relative to population norms (9926 steps/day). During the rehabilitation period, the step count was substantially reduced at 2 weeks (-4331;  $P < 0.001$ ) and at 6 months (-2763;  $P < 0.003$ ). However, at 12 months the mean daily step count was not significantly lower (-1050; NS) than the population norm. Energy expenditure (kcal/day) from PA was: presurgery 907 (269.5); 2 weeks 806 (321.1); 6 months 934 (321.9); 12 months 1111 (456.0).

**Conclusions:** This is the first study to provide objective, longitudinal characterization of the PA of ACL reconstruction patients. Presurgery, PA levels were significantly lower than age-matched population data. As expected, there was a reduction in daily step count during the initial postsurgery period. Limitations due to small sample size, duration of follow-up, and uncontrolled rehabilitation may have also contributed to failure to detect.

### Effect of 2 Running Shoe Types on Injury Rates in Recreational Runners: A Pilot RCT

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**Objective:** Running injury prevention efforts have led to the development of several running shoe technologies and, conversely, to the design of shoes with minimal biomechanical interference. The objective of this pilot study was to investigate the feasibility of a randomized controlled trial comparing the effect of Minimalist Shoes (MS) and Traditional Shoes (TS) on the incidence of running injuries among recreational runners training for a half-marathon.

**Study Design:** Twenty-four runners aged 18-45, with no more than 1 previous experience running a half-marathon were randomized to receive either MS or TS (choice of 6 different models within the assigned category) prior to undertaking a standardized 16-week training protocol. Subjects completed an online log of training sessions. The primary outcome was the incidence of injuries defined as 3 or more consecutive days of training missed or decreased by >50% because of pain. The cumulative incidence of injuries and 95% CI for the whole sample, MS, and TS groups were calculated. Bilateral chi-squared test with  $\alpha=0.05$  and  $1-\beta=0.8$  was used for sample size estimation.

**Results:** With minimal study advertisement, 24 eligible subjects were identified rapidly and all agreed to participate. Twenty (80%) were followed up to injury or the end of the study period. Baseline risk factors including demographic and biomechanical variables were similar across intervention groups. Out of 24 runners 3 (12.5%; 95% CI, 2.7%-32.4%) met the injury criteria

during the study period (2 in the MS group, 1 in the TS group, and 6 (25%; 95% CI, 9.7%-46.7%) received a diagnosis of running related injury following medical evaluation (3 in the MS group, 3 in the TS group).

**Conclusion:** This pilot demonstrates the feasibility of the proposed RCT with good recruitment and follow-up rates. The observed incidence of injuries and loss during follow-up suggest that, to detect a clinically significant difference of 20% in injury incidence between the MS and TS groups, a total of 105 subjects would be needed using the training log criteria and 183 subjects would be needed using medical diagnosis as the injury criteria.

**Acknowledgement:** Supported by the Canadian Academy of Sport and Exercise Medicine.

### Anterior Tibial Artery Flow Characteristics Do Not Change in Chronic Exertional Compartment Syndrome

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**Objective:** To test the hypotheses that patients with chronic exertional compartment syndrome (CECS) of the anterior leg compartment have an increased resistive index and peak diastolic reversal flow of the anterior tibial artery compared to controls postexertion using Doppler ultrasound.

**Study Design:** Prospective study.

**Subjects:** Four subjects with exertional leg pain who met our inclusion criteria and 9 controls.

**Intervention:** Four subjects with exertional leg pain who met our inclusion criteria and 9 controls participated in the study. Our Doppler ultrasonography technique was validated with a precision phase (10 controls) prior to scanning study patients. Subjects first ran on a treadmill until symptomatic ( $\geq 5$  minutes) using a standardized protocol. Spectral waveforms of the anterior tibial artery were measured using Doppler ultrasonography at the branching of the first arteriole distal to the knee, and anterior compartment pressures were measured prior to exercise and at scheduled intervals afterwards. Controls underwent the same regimen without needle testing.

**Outcome Measures:** Spectral waveform images were used to calculate the resistive index and peak diastolic reversal flow of the anterior tibial artery at rest and at scheduled intervals postexertion.

**Results:** Anterior compartment pressures were diagnostic of CECS using the modified Pedowitz criteria in all 4 patients. Resistive indices and peak diastolic reversal flows of the anterior tibial artery were not significantly different between groups at rest or at the scheduled intervals postexertion.

**Conclusions:** CECS patients do not have changes at rest or postexertion in the resistive index or peak diastolic reversal flow of the anterior tibial artery compared to controls. Thus, our findings suggest there is no difference in the flow characteristics in the anterior tibial artery of patients with CECS of the anterior compartment and controls at rest or postexertion.

One of the theories proposed to explain the underlying pain experienced by CECS patients is an imbalance in perfusion of active muscles. The findings of this study argue against this theory.

### Concussion Management in Academic Football Programs: Do We Meet the Standards?

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**Objective:** Head injuries in sports is a well-documented public health problem that led to the development of practice guidelines for the diagnosis and management of concussions. The objective of this study was to document the current status of concussion management in high school, CEGEP, and university football programs in the Quebec City area.

**Study Design:** This is a transversal descriptive study. A questionnaire was designed to assess the status of concussion management based on the current recommendations from the Zurich consensus (2008), Canadian Medical Association, American College of Sport Medicine, and National Athletic Trainers

Association. Validation of the questionnaire was done with a responder from outside the study area. Football program managers and the “main health professional” involved with each team were both interviewed. The high school (Juvenile AAA only; N = 6), CEGEP (N = 4), and university team (N = 1) of the Quebec City area were invited to participate.

**Results:** Participation by the 11 eligible teams was 100%. The “main health professional” was a physiotherapist for all teams. For the 2011 season, no team reported having a formal concussion management protocol, but 2 were planning to implement such a protocol for the 2012 season. Baseline neurocognitive testing is used by 1 highschool team and the university team. Baseline use of the SCAT2 was not reported. Following a concussion, the gradual return-to-play protocol of the Zurich consensus is used by all teams, but timely accessibility to medical clearance for “Full contact practice” was only reported by the university team, leaving the physiotherapist responsible for that decision in the vast majority of cases at the other levels.

**Conclusions:** The current standards of concussion management in academic football have been implemented only at the university level. Within the limit of the current resources, implementation of formal concussion management protocols involving baseline and postinjury SCAT2 or neurocognitive evaluation as part of the return-to-play process would greatly improve concussion management. The sports medicine community must be proactive in developing multidisciplinary approaches to improve timely access to medical expertise as part of proper sport concussion management at all academic levels.

### Concussion Education in Professional and University Sport: Does It Work?

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**Objective:** The first objective was to see the effectiveness of the lecture format when educating Canadian Interuniversity Sport (CIS) and Canadian Football League (CFL) football players about concussions. The second was to compare the differences between the CIS and CFL players regarding their knowledge of concussion.

**Study Design:** A prospective survey design.

**Subjects:** Sixty-eight CIS football players and 72 CFL football players.

**Intervention:** All players completed a 10-item concussion questionnaire. The questionnaire measured the players’ knowledge of concussion symptoms and the management of concussed players. The players did the questionnaire before and after a 1-hour presentation on concussion by a team physician.

**Outcome Measures:** Independent *t* tests compared results from the CIS and CFL players and compared results before and after the intervention.

**Results:** Descriptive statistics indicated that most players were knowledgeable about the symptoms and the management of concussion. Both groups demonstrated statistically significant improvements in knowledge on 2 questions including: 1) the recognition that concussions can come from blows to other parts of the body [F (1, 138) = 60.2;  $P \leq 0.05$ ] and that concussions are not easily detected by imaging [F (1, 138) = 7.1;  $P \leq 0.05$ ]. Independent *t* tests indicated that a significantly higher proportion of CFL players recognized the need for medical evaluations following a concussion than the CIS players (100% vs 67%;  $P \leq 0.05$ ) and felt it was safe to return to play within 24 to 48 hours after a concussion if they were asymptomatic (44% vs 26%;  $P \leq 0.05$ ).

**Conclusions:** The results suggested that a 1-hour concussion lecture provided by a team physician improved the football players’ knowledge. There are differences in athlete knowledge about concussion depending on the level of play. CFL players recognized the need for medical evaluation following a concussion; however, they also felt it was safe to return to play a day or 2 after a concussion. In addition to educating their players, team physicians must also customize their teaching according to the players’ level of play (ie, professional versus amateur).

**Examining Baseline Concussion Testing in Collegiate Sports**

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**Objective:** This study compared concussion baseline data among 3 contact collegiate sports to evaluate outcomes related to medical history and neurocognitive functioning.

**Study Design:** A retrospective, cross-sectional cohort design

**Subjects:** Two hundred seventy-four male Canadian Interuniversity sport athletes, including 155 football, 67 hockey, and 52 soccer players.

**Intervention:** Athletes completed baseline neurocognitive testing with ImPACT as part of preseason medical evaluations from 2010-2012.

**Outcome Measures:** The outcome measures included the history of previous concussions, the 5 composite scores from ImPACT (verbal memory, visual memory, visual motor, reaction time, and impulse control) as well as the Total Symptom Score.

**Results:** No significant differences were noted in demographic variables (age, years of education, or GPA) among the 3 sports. ANOVAs revealed significant differences for Visual Memory composite [ $F(2, 271) = 4.18; P \leq 0.05$ ] and Total Symptom score [ $F(2, 271) = 7.45; P \leq 0.05$ ]. Football players demonstrated the lowest Visual Memory scores among all 3 sports. Football players had higher mean symptom scores having more headaches, fatigue, drowsiness, irritability, and feeling more emotional. Hockey players had the highest proportion of players with a history of concussion in their medical history, followed by football, and soccer (65%, 56%, and 50%, respectively;  $P \leq 0.05$ ). Football players had the highest proportion incidence of players who suffered more than 1 concussion. There were also significant differences in injury characteristics [amnesia following concussion, ( $F(2, 271) = 3.82; P \leq 0.05$ ), with hockey players reporting significantly higher incidence of amnesia in previous concussions.

**Conclusions:** Our results suggest that football players report significantly higher concussion symptoms at baseline and have sustained multiple concussions compared to the other athletes tested. They also show poorer performance on tests of visual memory on the ImPACT test. These results were all collected at baseline when an athlete is considered "healthy" and asymptomatic. This data may cause us to reexamine how we interpret athletes' baseline testing after repeated concussions. Further studies examining baseline data in multiply concussed athletes are needed.

**Concussions in Hockey: Incidence, Knowledge and Pathway of Treatment**

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**Objective:** The purpose of this study was to determine the incidence, knowledge, and pathway of treatment for players that sustained a concussion during the 2011-2012 hockey season.

**Study Design:** Retrospective Cohort Study.

**Subjects:** A survey was administered to 7443 players between the ages of 13 and 21 years of age registered with the provincial hockey organization.

**Intervention:** Players were contacted by phone and traditional mail over a 3-month period.

**Results:** Of the 821 respondents, 498 (61%) reported having signs and symptoms of a concussion within the previous year. One hundred seventy-two players (35%) were diagnosed with a concussion by a medical doctor or the coach, and 53 players (38%) visited the ER for assessment. Over 90% of concussions occurred in a game, and 109 players had to miss more than 10 days of regular activity (school, friends, television, etc) due to the signs and symptoms of a concussion. If players followed the concussion guidelines endorsed by our national and provincial hockey organizations,

the results of our study indicated that 1099 physician visits would be required.

**Conclusions:** Although concussion treatment of athletes is well defined at the professional level, the lack of resources and education at the youth and amateur levels must be addressed so concussed individuals/athletes of all ages and skill levels can be managed appropriately.

**An Interdisciplinary Approach for Concussion Management in a High School Football Program**

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**Objective:** Although concussion management guidelines have been widely implemented in professional sports, limited resources represent a challenge for their implementation in academic settings. Our objective was to implement and evaluate an interdisciplinary model of concussion management within the limits of the resources available in a high school football program.

**Study Design:** A prospective cohort approach was used. A concussion protocol was developed in collaboration with a high school football program management team. A baseline neurocognitive evaluation was obtained for 41 Atome (age 11-12; 6 games), 73 Cadet (2 teams; age 13-14; 7 or 8 games) and 57 Juvenile (age 15-17; 12 games) athletes using the ImPACT software. Following exclusion from play, the return-to-play protocol, including balance testing, was applied by the team physiotherapist until medical clearance for unrestricted training was needed. A postinjury neurocognitive test was then administered by the coach or physiotherapist and submitted for review by the team doctor. E-mail was used for communications.

**Results:** Over the 2012 season and playoffs, 23 concussions were documented (Juvenile 15, Cadet 7, Atom 1). Nineteen concussions occurred during games, 2 during training, and 2 were unrelated to football. Following recovery to normal exercise and balance testing, 15 of 23 concussions (65%) were associated with an abnormal neurocognitive test result. Nine of these athletes were cleared for return to play after their second postinjury test, 4 after a third test and 2 follow-up were not completed upon submission. There were no reinjury following return to play following a concussion. Twenty distinct e-mail requests for analysis of up to 5 postinjury tests each time were sent to the team doctor over the 12-week season for a total of 42 postinjury tests.

**Conclusion:** The protocol used in this study resulted in a delayed RTP in 65% of concussed high school athletes that would have been returned to play on the basis of clinical evaluation in the past. The fact that no reinjury occurred suggests that proper clinical management and safe return to play was achieved using this approach. Using computerized neurocognitive evaluation and electronic communications allowed timely and cost effective access to medical advice about return to play through interdisciplinary collaboration.

**Academic Accommodation After Sport-Related Concussion: Educators' Workshop and Focus Groups**

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**Objective:** To evaluate educators' knowledge and implementation of sport-related concussion (SRC) management strategies at school and to determine how physicians, educational staff, and students can collaborate to design



academic accommodations for a student's optimal return to learn (RTL) after an SRC.

**Study Design:** Three 10-minute didactic lectures, followed by 90-minute facilitated focus groups at 15 tables during a professional development workshop at a sport-focused Ontario secondary school. The participants completed preworkshop (pre) and postworkshop (post) surveys.

**Subjects:** Ninety-four educational staff, including teachers, administrators, and 6 school psychologists.

**Intervention:** Participants learned about the nature and management of SRC with an emphasis upon RTL. A health care facilitator at each table recorded the highlights of the structured discussion. The surveys were reviewed to note changes from the pre- to the postsurvey and to collect suggestions from the participants. The educators created a draft rubric planner to assist students with RTL.

**Outcome Measures:** Educators were asked which accommodations they felt had been useful and which had not been useful, for the approximately 60 students who had RTL at that school, after an SRC during the prior 3.5 years.

**Results:** Eighty-one of the 94 participants submitted 2 matched pre- and postsurveys. Many educators indicated increased understanding of SRC management after the workshop. This is supported by statistically significant ( $P < 0.05$ ) answer changes between the pre- and the postsurvey, with educators' showing an increased support of accommodations. When asked to construct a rubric planner for students, several tables independently constructed a 4-stage RTL for students recovering from a SRC.

**Conclusions:** Over the past decade much emphasis has been placed upon the return to play after an SRC. However, RTL must be completed before considering a return to play. To effectively learn while recovering from a concussion, a student must be supported with academic accommodations that include instructional, assessment, environmental, and emotional considerations. Cognitive overload can precipitate an exacerbation of symptoms and thus delay full recovery. Educators must be consulted as key contributors to a physician-directed recovery. Ongoing collaboration between physicians, school-based staff and students is essential to facilitate a successful RTL.

### Sport-related Concussion Affects Cerebral Blood Flow Responses to Exercise

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**Objective:** To characterize the middle cerebral artery response to steady state exercise during the 1 month period following a sport-related concussion.

**Study Design:** Case study, longitudinal.

**Subjects:** One 20-year-old male diagnosed with a concussion following contact during football.

**Outcome Measures:** Middle cerebral artery velocity (MCAv) was assessed by transcranial Doppler at rest and during steady state light (30% heart rate reserve [HRR]) and moderate (70% HRR) intensity exercise. The subject was tested on days 3, 7, 14, and 30 postconcussion.

**Results:** On day 3, the MCAv (46cm/s) was reduced compared to healthy normative data (55-65cm/s). On day 7, 14, and 30 baseline MCAv was 47, 60, 64cm/s. During light and moderate exercise the MCAv was increased from baseline by 46% and 64%. The average increase in MCAv during light and moderate exercise in the literature is 15% to 20%. The relative increase from baseline in MCAv during light (12%) and moderate (18%) exercise on day 30 reached a more normative response. Heart rate (HR), mean arterial pressure (MAP), and end-tidal CO<sub>2</sub> (PetCO<sub>2</sub>) had normal responses to exercise and varied little over the 4 testing days. HR averaged over 3 minutes of steady state exercise reached precalculated HRR values for each given exercise intensity (102 bpm at 30% and 158 bpm at 70% HRR).

**Conclusions:** MCAv responsiveness to the exercise stimulus was amplified on day 3 compared to normative data from healthy subjects despite a normal PetCO<sub>2</sub> and MAP response. The large increase could be due to altered cerebral autoregulation, CO<sub>2</sub> reactivity, or a hypermetabolic state. Following 30 days of recovery, this increase in response was attenuated. Future studies with a larger sample size and age-matched controls subjects are required to further clarify the nature of this response.