429 SHORT TRACK VS HOCKEY HELMETS: USING FINITE ELEMENT ANALYSIS TO COMPARE STRAIN TO THE BRAIN

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Background Finite element analysis (FEA) is a computational modeling method widely used in materials and mechanical engineering to simulate the strain in a given physical system. The SIMon (Simulation Injury Monitor) is a finite element head model developed by the National Highway Traffic Safety Association in order to study how various impact conditions affect the human brain.
Objective Compare brain strain in high and low velocity impacts, between short track (ST) and ice hockey (IH) helmets.
Design Two-group experimental design.
Setting Data from previous impacts used in SIMon to model the human brain response to impacts.
Patients (or Participants) 5 different helmet models; 3 ST models and 2 IH models.
Interventions (or Assessment of Risk Factors) Assessment of ST and IH helmet impact attenuation under various conditions.
Main Outcome Measurements Cumulative Strain Damage Measure (CSDM) 15, 20 and 25. CSDM is the percentage of brain volume that crosses the 15%, 20% and 25% threshold. This has been shown to correlate with deformation-related brain injuries, such as Diffuse Axonal Injury.
Results One-way between-helmet ANOVAs for CSDM 15, 20 and 25 in low and high velocity impacts revealed statistical differences in CSDM 15, 20 and 25 [CSDM 15, $F(4, 34) = 70.7$, $p<0.05$; CSDM 20, $F(4, 34) = 63.4$, $p<0.05$; CSDM 25, $F(4, 34) = 32.5$, $p<0.05$]. The trend was that ST helmets outperformed IH helmets in rear, rear-boss and front-boss impacts, but that IH helmets outperformed ST in side impacts.
Conclusions The results of the FEA reveal a difference between the ST and IH helmets, with ST helmets generally outperforming IH helmets. Interestingly, these results are different than the results optained when comparing linear and rotational acceleration results for these same impacts. Currently, certifications only require peak linear acceleration values be below a certain threshold. However, these studies demonstrate the importance of using various outcome measures to determine the efficacy of helmets in sport.

430 A NOVEL VIRTUAL HELMET FIT ASSESSMENT FOR ICE HOCKEY AND RINGETTE PLAYERS AMIDST THE COVID-19 PANDEMIC

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Background Proper helmet fit is an important consideration for preventing head injuries, including concussions, in helmeted sports like youth ice hockey and ringette. Helmet fit assessments are typically completed in-person; however, this was not possible given COVID-19 restrictions. Thus, alternative considerations for virtual assessments were required.
Objective To examine the feasibility and inter-rater reliability of virtual ice hockey and ringette helmet fit assessments.
Design Cross-sectional.
Setting Calgary, Canada.
Participants Elite/upper division youth (ages 13–18) ice hockey (n=31 males) and ringette (n=30 females) players.
Assessment of Risk Factors Standardized ice hockey/ringette helmet fit criteria were developed and reliable for in-person assessments. Criteria were adapted for virtual delivery to participants over ZOOM video platform individually by two trained assessors per sport.
Main Outcome Measurements Twelve helmet fit criteria scored as yes/proper fit or no/poor fit were used to assess helmet shell fit (e.g., helmet fits snug, doesn't cover eyes), positioning (e.g., helmet is 1–2 finger widths above eyebrows, covers base of skull), facemask fit (e.g., chin piece fits, facemask does not move left/right), and others. Percent agreement (PA) between raters was used to describe inter-rater reliability, and each rater documented barriers for completing the assessments virtually.
Results Acceptable PA (>80%) was demonstrated for 8/12 criterion for ice hockey and 9/12 for ringette. Below acceptable agreement was found for all four criterion assessing the helmet facemask fit (PA range: 48%-74%) in ice hockey players and criteria for the chin straps fit (PA=66%), helmet positioning (PA=73%), and facemask fit (PA=63%) in ringette players. Common barriers were related to technology (e.g., audio/video quality) and environment (e.g., noisy, lighting).
Conclusions Virtual helmet fit assessments are feasible and reliable for most criteria, with more training required for criteria below acceptable agreement. Virtual assessments provides another option for assessing helmet fit for concussion prevention in helmeted sports.

431 PROTECTIVE EQUIPMENT IN YOUTH ICE HOCKEY: ARE MOUTHGUARDS AND HELMET AGE RELEVANT IN EVALUATING CONCUSSION RISK?

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Background The high concussion burden in youth ice hockey is concerning. An important yet understudied area for prevention is protective equipment (e.g., wearing a mouthguard, age of helmet).
Objective To compare rates of concussion between players based on mouthguard use and helmet age.

Design Prospective cohort.
Setting Calgary, Canada over five ice hockey seasons (2013/14–2017/18).
Participants Male and female youth ice hockey players ages 11–18.
Assessment of Risk Factors Participant baseline reports of mouthguard use (yes/always and sometimes use, no/never use), helmet age (newer/<2 years old, older/≥2 years old), and other important covariables [i.e., weight (kilograms), age group (under-13, under-15, under-18), position (forward, defense, goalie), concussion history (yes, no), body checking policy (allowed, disallowed)] were collected near the start of each season. Moreover, each player's participation hours were collected throughout each season.
Main Outcome Measurements Number of medically diagnosed or therapist identified suspected concussions using validated surveillance methodology in games and practices over 5 seasons of play.
Results Multilevel negative binomial regression adjusted for player position, level of play, body checking policy, concussion history, weight, cluster by team, and offset by player-hours was used. The model included 426 concussions suffered by 369 players (from 394 player-seasons; 29 players had recurrent concussions in a single season) over 4,541 player-seasons (271,148.7 player hours). The model demonstrated that players who reported wearing a mouthguard had a 28% lower rate of concussion compared to those who did not (IRR=0.72, 95%CI: 0.55–0.93). Moreover, there were no differences in the concussion rate between newer and older helmet ages (IRR=0.94, 95%CI: 0.76–1.16).
Conclusions Protective equipment is an important consideration for concussion prevention and player safety. Wearing a mouthguard was associated with a lower concussion rate and policy mandating mouthguard use should be considered in youth ice hockey. More specific helmet age categories may require further investigation.

432 FUNCTIONAL MOUTHGUARD DESIGN TO ENHANCE THE PROTECTIVE CAPABILITY AND ATHLETE COMFORT

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Introduction Athletes of contact sports are prone to cranial, orofacial and dental injuries in case of a traumatic head impact. Mouthguards can be potentially beneficial in reducing the injury risk by changing the dynamics of an impact to teeth. Indeed, dissipative capacity of mouthguard materials influences the extent of transferred force. However, the effect of geometrical/structural attributes should not be neglected on the mouthguards performance.
Objective The aim of this study is to evaluate the role of different design variables in protective capability of mouthguards and to find an optimal configuration by means of computer aided engineering.
Design and Setting A detail anatomical human upper jaw model was developed including teeth, periodontal ligament and maxilla bone. The incisor impact with an ice hockey puck was then simulated by finite element analysis with and without mouthguard. Various mouthguard configurations were designed by employing different material properties, laminated composite arrangement, layers thickness, and space inclusion.
Main Outcome Measurements The maximum effective stress on the incisors, contact force profile and stress distribution were compared to evaluate effect of different parameters on mouthguard protective performance.
Results While larger thickness always reduces the risk of injury in all configurations, the effectiveness of space inclusion and composite layers arrangement are design dependent. The optimal configuration was obtained when we combined graded stiffness layers (2000 to 20 Mpa) arrangement with a predefined gap (1 mm) in front of incisors. In this specific design, limiting the mouthguard thickness to 3 mm resulted in acceptable protective performance compared to 4 mm case and was preferred for the sake of athletes comfort.
Conclusion Both structural and material properties are playing a key role in shock absorbing capabilities of mouthguard. There is a need to practice multi-materials 3D printing for fabrication of customized mouthguards to maximize their performance and comfort.

433 COVID-19 AND SPORTS – AN ONLINE SURVEY ON THE IMPACT OF THE PANDEMIC AND POSSIBLE PREVENTIVE MEASURES

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Background The COVID-19 pandemic led to the implementation of worldwide governmental restrictions and preventative measures with large impact on social life.
Objective To investigate the effects of the pandemic on individual and general sport activities in an effort to provide information for safe return to community sports.
Design An electronic survey was launched in June 2020 in German and English language. The anonymous questionnaire collected epidemiological data and responses 'before','during' and 'after' confinement conditions. Descriptive statistics and logistic regression analysis were used.
Setting Most participants practiced their sport in Europe (93.9%); 68.5% were active athletes, 10.1% coaches, 10.1% had other sports functions, 11.3% indicated no regular sports activity.
Participants 1336 adults (30.5±11.7 years; 54.0% women) participated in the survey.
Assessment of Risk Factors Risk factors for a serious course of COVID-19 disease were queried.
Main Outcome Measurements The type, extent and intensity of physical activity were defined as main outcome measures.
Results During confinement, 15.7% could perform their main sport unrestricted, 43.5% stated a reduced amount of time spent on sporting activities, 46.4% a reduced intensity level. Most participants were neither aware of screening measures