2019 Sports Concussion Conference Abstracts

Rationale and design for a randomized, single-center, double-blind, sham-controlled study of non-invasive vagus nerve stimulation for treatment of post-traumatic headache

Bert Vargas, MD, FAAN; Eric Liebler; Stephen Bunt; Charlene Supent-Bell

Objective

Evaluate the efficacy and safety of non-invasive vagus nerve stimulation (nVNS) for the treatment of post-traumatic headache (PTH).

Background

Worldwide, ~69 million people per year sustain a traumatic brain injury (TBI), many of whom develop PTH. Clinicians often treat PTH with drugs approved for primary headache disorders, and many patients self-treat with over-the-counter agents but have inadequate pain relief. There has been little study of therapies for PTH, and safe, effective treatments are needed.

Design/Methods

This randomized, double-blind, sham-controlled, parallel-group pilot study is enrolling adults who present 1–4 weeks after a head injury, meet International Classification of Headache Disorders 3rd edition (ICHD-3) criteria for acute headache attributed to mild TBI, and have ≥2 headaches/week with a migraine or probable migraine phenotype. After a 2-week run-in period, subjects are randomly assigned (1:1 allocation) to receive daily preventive therapy and as-needed acute treatment with nVNS or a sham device. Preventive therapy consists of two 120-second stimulations 3 times daily. Acute treatment comprises 2 stimulations at headache onset and 2 stimulations 20 minutes after the start of initial treatment. Subjects are not to use acute rescue medication for 120 minutes post-treatment. One North American site will enroll ≤80 subjects. The expected duration is 12 months (enrollment, 9 months; participation, 14 weeks).

Results

The primary effectiveness end point is decrease in pain (on a 7-point scale) 60 minutes post-treatment for all treated headache attacks. Secondary end points include decrease in the frequency of headache days between the run-in period and the last 2 weeks of the double-blind period and responder rates (ie, percentages of subjects with ≥50% decrease in attack frequency). The primary safety end point is the incidence of treatment-related serious adverse events.

Conclusions

This study will assess the efficacy and safety of nVNS as a novel therapy for PTH.

Study Supported By: NA.

Disclosures: Dr. Vargas has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with American Headache Society, Headache Cooperative of the Pacific, ATI, Amgen, Novartis, Allergan, Alder, Teva, Lilly, Upsher-Smith, Biohaven, Promius, and Xoc. Neurology Today. Dr. Liebler has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with electroCore, Inc. Dr. Stephen Bunt has nothing to disclose. Dr. Supnet-Bell has nothing to disclose.

The Relationship between Headache Severity and Convergence Insufficiency in a Post-Concussive Population

Shaetu Datta, MD; Michael Jaffee; Russell Bauer; Adrian Svingos; Sarah Grief; Gabrielle Hromas; Kyle Zamajtuk; Tyler Bu

Objective

To examine the relationship between self-reported post concussion headache severity and convergence insufficiency (CI) a common binocular vision deficit, in a clinical post-concussive population.

Background

Both headache and CI are common sequelae of concussion that have been associated with prolonged recovery. Independent of head injury, CI is a known predictor of headache pain [1]. However, the relationship between CI and headache in a post-concussion population is less clear. This is an important relationship to explore since headaches are one of the most common and debilitating post-concussive symptoms.

Design/Methods

Retrospective databank analysis was conducted of 174 participants between the ages of 13–84 (M = 37 SD = 19) recruited from an interdisciplinary concussion clinic (M = 295 SD = 609 days post-injury). Near point convergence (NPC) and subjective headache severity were obtained by a neurologist during routine clinical visits. Near point convergence was dichotomized: >5 cm being CI, and <5 "normal." Current headache severity was measured using a self-report pain severity scale ranging from 0 (none) to 10 (most severe). Spearman rank-order correlation was used in order to elucidate the relationship between headache severity and CI.

Results

Results suggest only a weak relationship between post-concussion headache severity and NPC status that failed to reach statistical significance (r = 0.171, p = 0.098). NPC status explained only 3% of the variance in headache severity.

Conclusions

The results of this study suggest that headache and NPC measurements following concussion are very weakly associated. Given the episodic nature of headaches, it may be that statistically significant correlations are not evident unless there is a certain headache severity at time of NPC measurement. Future studies are needed in order to determine whether and to what extent injury severity or patient demographic characteristics mediate this relationship.

Study Supported By: University of Florida.

Disclosures: Dr. Datta has nothing to disclose. Dr. Jaffee has nothing to disclose. Grant support from NCATS, NINDS, VA RR&D, and NIA. Dr. Svingos has nothing to disclose. Dr. Grief has nothing to disclose. Dr. Hromas has nothing to disclose. Dr. Zamajtuk has nothing to disclose. Dr. Bu has nothing to disclose.

Reference

[1] Singman Eric, Matta Noelle & Silbert David. (2014). Convergence Insufficiency Associated with Migraine: A Case Series. The American orthoptic journal. 64. 112-6. 10.3368/aoj.64.1.112

Correlations between qEEG volumetric analysis and computerized cognitive testing shortly after sport concussion injury in high school athletes

Harry Kerasidis, MD; Paul David Ims; Stacie Rector

Objective

To evaluate correlations between sLORETA quantitative electroencephalogram (qEEG) analysis and a computerized symptom and neurocognitive performance assessment.

Background

We previously reported results of sLORETA qEEG deregulation in recently concussed high school athletes. Correlations between this deregulation and concussion symptoms and neurocognitive performance have not been described in this population.

Design/Methods

EEGs were analyzed in 61 high school athletes shortly after concussion injury using sLORETA imaging compared to a normative database (NYU/BrainDx). Concussion related symptoms and neurocognitive performance were assessed (XLNTbrain). Peak Z-score variation (PZV), and %volume of grey matter activity falling outside Z = −2.5 to

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2.5 were calculated for 5 EEG frequency bands. Pearson correlation coefficients were calculated between the qEEG findings and the cognitive performance testing. Statistical comparisons were made between athletes endorsing high symptom scores vs. low scores.

Results

Statistically significant positive correlations were observed between performance on verbal go/nogo, emotional recognition of happy and angry faces and volume and severity of sLORETA deregulation suggesting a pathological relationship. This deregulation consisted primarily of deficient activity in the delta, theta, beta, and beta-gamma bands. Significant negative correlations were observed between performance on nonverbal go/nogo, emotional recognition of angry faces, motor tapping, sentence completion, facial recognition, and word recognition and volume and severity of sLORETA deregulation suggesting compensatory mechanisms. This deregulation consisted primarily of excess activity in the alpha and theta bands. Elevated scores for migraine, worry, and mood were associated with increased severity and volume of increased activity in the beta and beta-gamma bands. Athletes with elevated vestibular symptoms had lower theta band deregulation.

Conclusions

This study demonstrates correlations between performance on computerized neurocognitive tasks and changes in sLORETA qEEG analysis shortly after concussion injury in high school athletes. The data suggest some of these changes are pathological, while others are compensatory.

Study Supported By: Self-funded.
Disclosures: Dr. Kerasidis has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities Stress Therapy Solutions. Dr. Kerasidis holds stock and/or stock options in Concussion Management LLC. Dr. Ims has no disclosures. Dr. Rector has no disclosures.

Validation of a Concussion Assessment Tool

Sasidharan Taravath, MD; Megan Peedin, NP; Mark Williams; Len Lecci; Julian Keith

Objective

Sports related concussions, or mild traumatic brain injuries, have been steadily increasing over the past two decades. Effective screening and identification of concussions play a critical role in the diagnosis and rehabilitation process. Although side line assessment tools are available, there are few well validated tests available to assist medical providers in this decision-making process. This study aims to determine whether previously validated tools which assess neurocognitive and neurophysiological abilities can predict concussion symptom endorsement in a sample of child and adolescent athletes.

Background

Participants were recruited from two settings: The office of a pediatric neurologist (seen 3 to 109 days post incident) and from preseason baseline assessments.

Design/Methods

Method: Participants were 113 individuals, aged 6 to 17, representing 84 consecutive cases of individuals completing standardized baseline assessments with no recent history of concussion, and 29 consecutive cases undergoing a post-concussion evaluation by a pediatric neurologist. Participants completed a standardized battery of tests comprised of the Connors' Continuous Performance Test (CPT-3), the Balance Error Scoring System (BESS) and the NIH 4-meter Gait Test and completed a checklist of CDC concussion symptoms.

Results

The screening battery explained 33% of the variance (d = 1.4) in concussion symptom endorsement, after controlling for age. The neurocognitive test alone (CPT-3) accounts for 21.5% of the variance (d = 1.05) in symptoms after controlling for age, and the neurobehavioral measures (BESS and NIH 4m Gait) then account for an additional 11.5% variance (they account for 18.6% variance, d = 0.96, when entered first). These effect sizes are considered large to very large and reflect a marked increase in predictive validity relative to existing measures used in concussion assessments.

Conclusions

An easy to administer and relatively brief screening test can be used in medical settings to identify concussions and predict significant and substantial variability in CDC concussion symptoms.

Study Supported By: NA.
Disclosures: Dr. Taravath has nothing to disclose. Dr. Peedin has nothing to disclose. Dr. Williams has nothing to disclose. Dr. Lecci has nothing to disclose. Dr. Keith has nothing to disclose.

Heart Rate Variability and Mild Traumatic Brain Injury: Case Study and Review of Literature

Harrison Seltzer; Karim Elghawy; Robert Baker

Objective

Use biofeedback measures to manage a patient's long term recovery from concussion.

Background

Sports-related mild traumatic brain injury (MTBI) is estimated to affect 3.8 million people in the United States. Identifying quantitative measures of recovery has become a point of interest in treatment. Heart Rate Variability (HRV), the average fluctuation in the interval between heartbeats, shows promise as a noninvasive biomarker.

Design/Methods

Case report following cardiovascular recovery of a 15 year old cross country runner 4 months post-injury. Average heart rate and maximum heart rate per training session were collected from the patient's smart device.

Results

A 15-year-old Caucasian male cross-country runner hit the back of his head during a soccer game suffering an MTBI. The patient rested from the activity for 1 week then returned to training. Two months after the injury the patient complained of persistent shortness of breath, fatigue, and increased heart rate while running. According to the patient, his average BPM while running prior to the injury was in the 160s. The patient's smart device post-concussion reports a spike into the 180s. 3 months post-concussion the patient was instructed to keep his heart rate below 170 during training. In the following month, the patient's condition improved gradually with a return to baseline activity.

Conclusions

HRV is a promising point of investigation for the management of post-concussive symptoms. Further research is necessary to elucidate the long term effects of concussion on heart rate variability.

Study Supported By: Western Michigan Homer Stryker M.D. School of Medicine Department of Sports Medicine.
Disclosures: Dr. Seltzer has nothing to disclose. Dr. Elghawy has nothing to disclose. Dr. Baker has nothing to disclose.

The association between a history of self-reported concussion and response inhibition: a population-based study

Clara Alexandra Stafford; Bobby Stojanoski; Conor Wild; Adrian Owen

Objective

We investigated the long-term cognitive effects of concussion in almost 20,000 members of the general population, using tests that are known to be sensitive to small changes in performance.

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Background

Concussions are the most common type of mild traumatic brain injury, with clinical symptoms such as headaches, dizziness, and nausea, persisting for months post-injury. Despite a growing understanding of the severity and duration of these symptoms, very little is known about the long-term effects of concussion on higher level cognitive functioning and emotional lability.

Design/Methods

We asked 19,261 participants to complete a demographic questionnaire as well as the Cambridge Brain Sciences (CBS) cognitive battery. We divided our sample into two groups: those reporting at least one concussion in their lifetime (post-concussion) and those reporting no concussions in their lifetime (non-concussed). We compared the performance of the two groups on the 12 CBS tasks, as well as on four non-cognitive variables measuring levels of social contact, anxiety, depression, and concentration difficulties.

Results

We found that post-concussion individuals performed significantly worse on a modified Stroop task that measures aspects of response inhibition, but were no worse on any other cognitive measure, including short-term memory, reasoning, and verbal abilities. Crucially, performance profiles of the post-concussion individuals indicated that they made more errors on trials that involved an incongruent colour/word pair. Beyond measures of cognition, we found that post-concussion participants also reported higher levels of anxiety, depression, and trouble concentrating when compared to the non-concussed group. The number of reported concussions also predicted task scores on this task only.

Conclusions

Our results suggest that sustaining a concussion is not associated with long-term global effects on cognition. Those who report at least one concussion appear to have a modest, but statistically significant deficit of response inhibition. This impairment seems to be related to the number of concussions reported.

Study Supported By: This work was supported by a Canada Excellence Research Chairs (CERC) Program grant awarded to AO.
Disclosures: Dr. Stafford has nothing to disclose. Dr. Stojanoski has nothing to disclose. Dr. Wild has nothing to disclose. Dr. Owen has nothing to disclose.

EEG Markers of Cognitive Engagement

Ashleigh Kennedy; Jordan Hassin

Objective

The purpose of this study was to use portable electroencephalography and qualitative assessments to characterize cognitive changes associated with perceived increase in mental load and to identify markers of mental fatigue in these individuals.

Background

The ability to focus on cognitive tasks impacts everything from our social interactions to our success in the classroom or workplace. Concussion negatively impacts the ability to focus and causes patients to experience signs of mental fatigue more quickly than those without concussion. The mechanisms behind these changes are still not well understood.

Design/Methods

Fifteen concussion patients and fifteen age-matched controls were recruited to participate in this study. Participants performed two, thirty-minute testing sessions spaced 1 month apart. In each session, participants performed 8 cognitive tasks eliciting varying levels of cognitive activity. Cognitive activity was quantitatively assessed using a MUSE non-invasive EEG headset. These data were compared to a perceived level of cognitive activity determined by the individual using the Klepsh et al (2017) cognitive engagement scale and mental fatigue assessed by the Mental Fatigue Scale (Johansson2014).

Results

The results demonstrate that frequency based EEG changes correlated with decreased ability to focus on the cognitive task and with perceived cognitive fatigue in both concussion patients and healthy controls.

Conclusions

Future studies should utilize the same methods to monitor cognitive activity differences during daily functional living.

Study Supported By: Neurovine
Disclosures: Dr. Kennedy has nothing to disclose. Dr. Hassin has nothing to disclose.

Nonverbal hand movement durations indicate post-concussion symptoms of athletes

Ingo Helmich, PhD; Lausberg Hedda

Objective

Concussions are common in sports and appear to be a risk factor for cognitive impairment and mental health problems. Methods of post-concussion diagnosis are still of debate, regarding sensitivity, objectivity, reliability, and costs. Spontaneous displays of nonverbal hand movement behavior during interaction are indicative of psychopathology and relatively simple to record and analyze.

Background

Increased durations of continuous (/irregular) body-focused hand movement activity in particular indicates psychopathology that overlaps in symptomatology with that of sport related concussions (SRC). We therefore hypothesized that the duration of irregular, on body, and act on each other hand movements is increased in athletes with SRC who suffer from post-concussion symptoms.

Design/Methods

Three matched groups were investigated: 14 symptomatic athletes with a concussion, 14 asymptomatic athletes with a concussion, and 12 non-concussed athletes. Four certified raters analyzed with the NEUROGES analysis system all nonverbal hand movements that were displayed during a videotaped standardized anamnesis about concussion history, incidence, course of action, and post-concussion symptoms.

Results

Irregular Structure units of symptomatic athletes are significantly longer when compared to asymptomatic athletes. Hand movement durations of irregular, on body, and act on each other correlate positively with post-concussion symptoms. The duration of irregular units significantly predicts the PCS score.

Conclusions

Increased durations of irregular hand movement units indicate post-concussion symptoms in athletes with sport-related concussions. Because the recording of spontaneous displays of nonverbal hand movement behavior is relatively simple and cost-efficient, we suggest using the neuropsychological analysis of hand movement behavior as a future diagnostic parameter of concussion management protocols.

Study Supported By: University research funding of the German Sports University, Cologne (L-11-10011-175-122000).
Disclosures: Dr. Helmich has nothing to disclose. Dr. Hedda has nothing to disclose.

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Sex differences in Sport-related Concussion in Japan

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Objective

To evaluate the Sex differences in Sport-related Concussion in Japan.

Background

We dont't have the knowledge about the sex differences in SRC in Japan.

Design/Methods

The study design was retrospective study. Facility is Toho University Ohashi Medical Center Neurosurgery Sports-related head injury clinic. The search period is April 2017 to February 2018. Inclusion criteria were as follows: 1) Sports-related head injury cases, 2) Physician-diagnosed Sports-related concussion, 3) Underwent evaluation by the same neurosurgeon, 4) More than 28 days continued follow-up. The following items were compared male and female. The examination items were as follows: 1) Age/sex, 2) competition item, 3) prior concussion, 4) Migraine history, 5) persistent post concussive symptoms. Statistical analysis used *t* test.

Results

The 140 selected cases were 114 male (Group M: GM) and 26 female (Group F: GF). The mean Age of both GM and GF was 20 years. The most majority competition item of GM was Rugby football. On the other hand, GF was lacrosse. 42 cases of GM and 9 cases of GF suffered prior concussion ($p > 0.05$, no significant). 19 cases of GM and 6 cases of GF had migraine history ($p > 0.05$, no significant). 37 cases of GM and 16 cases of GF had PPCS ($p < 0.05$).

Conclusions

Our result suggests that female players explain the significant difference in the prevalence of PPCS in Japan.

Study Supported By: NA.

Disclosures: Dr. Nakayama has nothing to disclose. Dr. Hiramoto has nothing to disclose. Dr. Fujita has nothing to disclose. Dr. Sato has nothing to disclose. Dr. Suzuki has nothing to disclose. Dr. Hirai has nothing to disclose. Dr. Saito has nothing to disclose. Dr. Hayashi has nothing to disclose. Dr. Ito has nothing to disclose. Dr. Sakurai has nothing to disclose. Dr. Aoki has nothing to disclose. Dr. Iwasbuchi has nothing to disclose.

Preliminary Concussion and Lower Extremity Injury Risk Among R.O.T.C. Cadets

Katie Hunzinger; Katelyn Costantini; Kelsey Bryk, MSc; Thomas Buckley, PhD; C. Buz Swanik

Objective

To examine the association between concussions and lower extremity musculoskeletal injury (LE-MSI) rates in Reserve Officer Training Corps (ROTC) cadets.

Background

Concussions have been associated with an increased risk for LE-MSI among high school, collegiate, and professional athletes as well as U.S. Army Soldiers. However, there is a paucity evidence on this relationship among U.S. Army ROTC cadets, future U.S. Army Officers, and a group similar to student-athletes in regards to physical activity levels.

Design/Methods

A modified reliable injury questionnaire (ICC = 0.92) was used to identify the total number of reported concussions, intentionally unreported concussions, and potentially unrecognized concussions (e.g., memory loss not diagnosed as a concussion) as well as LE-MSI (e.g., muscle strains, ACL rupture) a cadet had suffered. A chi-square analysis was performed to identify the association between concussion and LE-MSI and any concussive injury and LE-MSI.

Results

47 cadets (19.9 ± 1.3 years) were recruited from one Army ROTC program. There was not a significant association between reported concussions and LE-MSI ($X(1) = 3.122$, $p = 0.077$). There was not a significant association between any concussive injury (reported, unreported, or potentially unrecognized) and LE-MSI ($X(1) = 3.590$, $p = 0.058$). The reported concussion history was 38.3% (18/47), any concussive history was 46.8% (22/47), and 68.1% (32/47) reported history of LE-MSI.

Conclusions

Preliminary results showed that there was no statistically significant association between concussion and LE-MSI among ROTC cadets at this university. Future research is warranted on a larger cohort of cadets to determine if this relationship exists since cadets will soon commission, potentially risking injury while serving on active duty, causing limited duty days, reduced Department of Defense readiness, and increased healthcare costs. Cadets showed a high incidence of concussion and LE-MSK injury, and future research should target reducing these injuries among ROTC cadets prior to commissioning.

Study Supported By: NA.

Disclosures: Dr. Hunzinger has nothing to disclose. Dr. Costantini has nothing to disclose. Dr. Bryk has nothing to disclose. Dr. Buckley has nothing to disclose. Dr. Swanik has nothing to disclose.

Thalamic and thalamic projection abnormalities on DTI and NODDI analysis following acute concussion

James Houston, MD; Frank Skidmore, MD; William Monroe; Jon Ambrugy; Mitchell Self

Objective

To compare preseason and post-concussive MRI in a cohort of collegiate football players utilizing Diffusion Tensor Imaging (DTI) and Neurite Orientation Dispersion and Density Imaging (NODDI) post processing.

Background

Acute post-concussive symptoms can vary in clinical characteristics and severity. However, vestibular and ocular dysfunction in particular, has been associated with poor clinical outcomes. The vestibular system comprises a complex network of projections from peripheral vestibular organs to thalamic relay systems and numerous cortical regions. The visual/oculomotor system is also complex, involving brainstem, subcortical-cortical and thalamo-cortical connections. Oculomotor deficits are thought to involve the midbrain and the visual and parietal association cortices, both of which have thalamic projections.

Design/Methods

We gathered pre-season MR diffusion weighted imaging on a cohort of 30 collegiate football players. We performed repeat imaging within 36 hours of any diagnosed concussion in the same subject cohort. DTI metrics: mean diffusivity (MD), axial diffusivity (AD), fractional anisotropy (FA), and radial diffusivity (RD) along with NODDI metric: orientation dispersion index (ODI), were analyzed for statistical comparisons between groups.

Results

4 subjects with pre-season MRI underwent repeat MRI within 36 hours of concussive injury. A paired t-test between these two groups using DTI and NODDI metrics showed significant ($p < 0.05$) decreases in: AD and

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MD in the left posterior thalamic radiations, FA in the column and body of the fornix, and MD in the right anterior corona radiata and superior fronto-occipital fasciculus, and a significant decrease in ODI in the anterior thalamus.

Conclusions

Disruptions in the thalamus and its white matter projections may play a role in the vestibular/ocular dysfunction associated with acute concussive injury. While our numbers are small, the findings suggest that DTI and NODDI processing techniques have the capability to locate and measure grey and white matter injury patterns after concussive injury.

Study Supported By: UAB Research and Education Program in Neurology, Neurosurgery, and Neuropathology.
Disclosures: Dr. Houston has nothing to disclose. Dr. Skidmore has nothing to disclose. Dr. Monroe has nothing to disclose. Dr. Amburgy has nothing to disclose. Dr. Self has nothing to disclose.

Greater Accuracy in Concussion Diagnosis in Collegiate Athletes through the use of Blood Brain Biomarkers

Anand Tripathi; Sundeep Dhanju; Steve Rowson; Eric Smith; Mike Goforth; Mark Rogers; Per Gunnar Brolinson

Objective

The primary aim is to document the cumulative neuropathologic burden of sport-related concussion via brain biomarkers (e.g., S100B and GFAP) in collegiate athletes at baseline, during the acute phase of a concussive injury, at return to play, and upon completion of collegiate athletic participation.

Background

Sport-related concussion is a major public health concern currently. Yet, the diagnosis is all done clinically, without a standardized objective measurement that could definitively implicate the presence of a concussion. Previous studies have shown blood brain biomarkers to be useful in determining the diagnosis of traumatic brain injury. Indeed, few studies have shown biomarkers that are highly sensitive and specific for detecting concussion in the general population and the FDA has approved such a biokit for public use. This biokit is used to determine if a brain CT scan is needed for an alert patient that presents to the emergency department following head trauma. However, much more work is needed to for concussion diagnosis in collegiate athletes.

Design/Methods

A retrospective study is being conducted to analyze the blood biomarkers and head acceleration data collected from a pilot project. Four different groups are being used in this study: (1) nonimpact, (2) vigorous athletic controls (swimming, running, and baseball), (3) non-concussed football player (active controls), and (4) concussed football players.

Results

Preliminary results indicate significant differences in the means for the aforementioned groups ($F = 3.85$, $df = 5.69$ $p = 0.0070$, $n = 74$). Serum S100B levels are also significantly different for pre- and post-concussion groups ($F = 4.51$, $p = 0.0405$, $df = 37$).

Conclusions

There is a statistical difference in the blood biomarker levels in concussed versus non-concussed players. Current work is being undertaken to correlate head acceleration data to serum biomarker findings of concussion at baseline, post injury and completion of collegiate athletic participation to further study biomarker as a diagnostic tool in athletes.

Study Supported By: VCOM Research Division.
Disclosures: Dr. Tripathi has nothing to disclose. Dr. Dhanju has nothing to disclose. Dr. Rowson has nothing to disclose. Dr. Smith has nothing to disclose. Dr. Goforth has nothing to disclose. Dr. Rogers has nothing to disclose. Dr. Brolinson has nothing to disclose.

A Comparison of Football and Rugby Tackling During Spring Ball

William Garrett; Suzanne Konz

Objective

The study examined the effects tackling style has on forces translated to the brain in football and rugby.

Background

Tackling is linked to concussion due to high or repetitive impact forces. A small number of NFL teams are incorporating the rugby tackle mechanics due to keeping the head out of the way. Rugby style tackle use is increasing in football.

Design/Methods

A convenient sample of 30 male football and rugby participants from two universities participated in this observational study. 20 football participants (20 ± 1.61 YO, 71.63 ± 2.71 in, 210.84 ± 45.52 lbs.) had impact sensors placed in the helmet (CUE™ Sports Sensor, Athlete Intelligence, Kirkland, WA) and 10 rugby participants (20.22 ± 3.31 YO, 70.78 ± 2.11 in, 211.78 ± 40.62 lbs.) were fitted with an instrumented mouthguard (VECTOR™ Sports Sensor, Athlete Intelligence, Kirkland, WA) during their respective spring seasons. Participants practiced without intervention. Devices were returned to researchers after activity, and the data was uploaded. Welch's ANOVA with a Games-Howell post-hoc analyzed the data with significance set at 0.05.

Results

Football participants tallied 3921 impacts over the course of 12 practices, compared to 1868 impacts over 9 practices received by rugby participants. Welch's ANOVA determined that there is a difference in the frequency of impacts between football and rugby participants (*Welch's F* (1, 4119.84) = 29.41, $p < 0.001$). Football participants encountered linear impacts at 62.95 ± 36.57g. Rugby participants sustained impacts 20.59 ± 15.79g. The Welch's ANOVA determined a difference in impact force between the football and rugby participants exists (*Welch's F* (1, 5741.884) = 3780.385, $p < 0.001$).

Conclusions

Impact frequency appears to be lower in rugby athletes than football athletes during spring ball. Also, the average impact force appears to be less in rugby athletes. The use of a rugby-style tackle generated lower impact forces in athletes when contact occurs.

Study Supported By: This study does not have any financial support.
Disclosures: Dr. Garrett has nothing to disclose. Dr. Konz has nothing to disclose.

Concussion prevention strategies: A Survey of division I and division II female soccer teams

Kara Radzak

Objective

The purpose of this study is to evaluate concussion prevention strategies being used in NCAA Division I and Division II women's soccer and characterize the beliefs of Certified Athletic Trainers (ATs) on concussion prevention methods.

Background

While much attention has been paid to decreasing concussion rates in collegiate woman's soccer, it is unknown what prevention strategies are currently being performed. Additionally, ATs' beliefs on the efficacy of concussion prevention practices for these athletes is unknown.

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Design/Methods

Participants included ATs employed at any of the 334 Division I or 273 Division II universities working with woman's soccer. A survey instrument of structured questions followed by open-ended follow up questions was developed to identify if teams utilized cervical strengthening programs, headgear, or other techniques for concussion prevention. Questions also address ATs' beliefs on the effectiveness of cervical strengthening, headgear and mouthguards in concussion prevention. Data were collected via questionnaire e-mailed through Qualtrics survey software. Responses were received from 222 ATs (37.8% response rate). Data were analyzed via descriptive statistics.

Results

Some form of cervical strengthening or stability for concussion prevention was performed by 38 teams (17.12%) and seven (3.15%) were unsure. The majority (69.86%) believe such programs will aid in concussion prevention. Equipment for concussion prevention was report by 36 (16.59%). Text responses included mouthpieces (n = 3) and headgear (n = 31). Seventy-eight (35.49%) reported players on their team wear headgear. Nineteen (8.76%) believe headgear prevents concussions. Forty-five (20.74%) believe mouthguards prevent concussions. Proper soccer technique is implemented by 151 (69.59%) and 14 (0.06%) cite nutritional strategies for concussion prevention.

Conclusions

Although most ATs believe that cervical strengthening aids concussion prevention, few programs are implementing this strategy. Disconnect exists between available evidence and the perceptions held by ATs regarding mouthguards and headgear for concussion prevention.

Study Supported By: This study does not have any financial support.
Disclosures: Dr. Radzak has nothing to disclose.

Age of first exposure to soccer heading and sensory reweighting for upright stance

Jaclyn Caccese, PhD; Fernando Santos; Felipe Yamaguchi; John Jeka

Objective

To compare sensory reweighting for upright stance between soccer players who began soccer heading before age 10 years (AFE ≤ 10) and those who began soccer heading after age 10 years (AFE > 10).

Background

In 2015, US Soccer announced an initiative to eliminate soccer heading for youth players ages 10 years and younger and to limit soccer heading for children ages 11 to 13 years. Limited empirical evidence associates soccer heading during early adolescence and long-term behavioral deficits.

Design/Methods

Thirty college-aged soccer players self-reported AFE to soccer heading. Sensory reweighting was compared between AFE ≤ 10 [n = 19, 11 males (58%), 22 ± 3 years, 171 ± 9 cm, 70 ± 11 kg, 5 with concussion history (26%)] and AFE > 10 [N = 11, 5 males (45%), 22 ± 2 years, 172 ± 7 cm, 69 ± 13 kg, 3 with concussion history (27%)]. To evaluate sensory reweighting, we simultaneously perturbed upright stance with visual (i.e., moving visual scene at 0.2 Hz), vestibular (i.e., ±1 mA bilateral monopolar galvanic vestibular stimulus (GVS) at 0.36 Hz), and proprioceptive stimulation (i.e., 80 Hz vibratory stimulus to their bilateral Achilles tendons at 0.28 Hz). The visual stimulus was presented at different amplitudes (i.e., 0.2 m, 0.8 m in the anterior-posterior (AP) direction) to measure the leg-segment AP displacement change in gain to vision, an intramodal effect; and change in gain to GVS and vibration, both intermodal effects. A repeated-measures ANOVA was used to compare sensory reweighting between groups.

Results

There were no differences in gain to vision ($F_{1,28} = 0.033$, $p = 0.857$, $\eta^2 = 0.001$), gain to GVS ($F_{1,28} = 0.001$, $p = 0.971$, $\eta^2 = 0.000$), or gain to vibration ($F_{1,28} = 0.001$, $p = 0.974$, $\eta^2 = 0.000$), and no differences in sensory reweighting (i.e. conditionXgroup effect; vision, $F_{3,84} = 0.160$, $p = 0.923$, $\eta^2 = 0.006$; GVS, $F_{3,84} = 0.043$, $p = 0.988$, $\eta^2 = 0.002$; vibration, $F_{1,28} = 0.068$, $p = 0.797$, $\eta^2 = 0.002$).

Conclusions

There were no differences in sensory processing for upright stance between AFE ≤ 10 and AFE > 10, suggesting that soccer heading during early adolescence is not associated with balance deficits in college-aged soccer players, notwithstanding potential deficits in other markers of neurological function.

Study Supported By: NIH-NINDS R01 (NS102157–01) grant.
Disclosures: Dr. Caccese has nothing to disclose. Dr. Santos has nothing to disclose. Dr. Yamaguchi has nothing to disclose. Dr. Jeka has nothing to disclose.

Repetitive head impact exposure and sensory reweighting for upright stance

Felipe Yamaguchi; Jaclyn Caccese, PhD; Fernando Santos; John Jeka

Objective

To compare sensory reweighting between soccer players who report higher exposure to soccer heading and those who report lower exposure to soccer heading.

Background

Exposure to repetitive head impacts (RHI), such as through routine soccer heading, may have potentially detrimental effects.

Design/Methods

Thirty participants completed a self-reported questionnaire to estimate the number of RHI sustained weekly, and were divided into low-, medium-, and high-RHI groups based on their responses. Sensory reweighting was compared between low-RHI (N = 10, 4 males, 22.9 ± 3.0 years, 170.5 ± 7.7 cm, 70.0 ± 12.14 kg, 2 ± 2 RHI) and high-RHI groups (N = 10, 5 males, 20.0 ± 1.1 years, 170.4 ± 7.4 cm, 69.6 ± 13.4 kg, 60 ± 37 RHI). Participants experienced a visual stimulus at 0.2 Hz, a ±1 mA binaural monopolar galvanic vestibular stimulus (GVS) at 0.36 Hz, and a vibratory stimulus to their bilateral Achilles tendons at 0.28 Hz during standing. The visual stimulus was presented at different amplitudes (0.2, 0.8 m translation in the anterior-posterior direction) to measure the change in leg gain to vision, gain to vibration, and gain to GVS. A repeated-measures ANOVA was used to compare sensory reweighting between groups.

Results

There were group differences in sensory reweighting for leg gain to GVS (i.e. condition X group effect; $F_{3,54} = 5.068$, $p = 0.004$, $\eta^2 = 0.220$), whereby the high-RHI group did not reweight gain to GVS across conditions, and gain to vision ($F_{3,54} = 3.397$, $p = 0.024$, $\eta^2 = 0.159$), whereby the high-RHI group had higher gains than the low-RHI group in the 0.2 m visual stimulus condition. There were no group differences in sensory reweighting for gain to vibration ($F_{1,18} = 0.045$, $p = 0.834$, $\eta^2 = 0.003$).

Conclusions

Routine soccer heading is associated with relatively high head accelerations. These results suggest that exposure to frequent RHI may induce adaptation that diminishes reliance on vestibular function. Consequently, visual feedback is upweighted to maintain balance during upright stance.

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Disclosures: Dr. Yamaguchi has nothing to disclose. Dr. Caccese has nothing to disclose. Dr. Santos has nothing to disclose. Dr. Jeka has nothing to disclose.

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Estimated age of first exposure to American football and outcome from concussion

Jaclyn Caccese, PhD; Zac Houck; Thomas Kaminski; James Clugston; Grant Iverson, PhD; Kelsey Bryk, MSc; Jessie Oldham; Paul Pasquina, MD; Steven Broglio, PhD; Thomas McAllister, PhD; Thomas Buckley, PhD

Objective

To examine the association between estimated age of first exposure (eAFE) to American football and clinical measures throughout recovery following concussion.

Background

In collegiate football players, we reported no association between eAFE and baseline neurocognitive function. It is possible that neurocognitive deficits from earlier eAFE to American football, if present, are sufficiently compensated for in otherwise healthy individuals, but when faced with concussion, earlier eAFE may associate with longer symptom recovery, worse cognitive performance, or greater psychological distress.

Design/Methods

Participants were recruited as part of the NCAA–DoD Concussion Assessment, Research and Education (CARE) Consortium. There were 340 NCAA football players (age = 18.9 ± 1.4 years) who were evaluated 24–48 hours following concussion and had valid baseline data and 360 (age = 19.0 ± 1.3 years) who were evaluated at the time they were asymptomatic and had valid baseline data. Participants sustained a medically-diagnosed concussion between baseline testing and post-concussion assessments. Outcome measures included the number of days until asymptomatic, Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) composite scores, Brief Symptom Inventory 18 (BSI-18) sub-scores, and Hospital Anxiety and Depression Scale (HADS) scores. The eAFE was defined as the participant's age at the time of assessment minus the self-reported number of years playing football.

Results

Results of generalized linear modeling suggested that younger eAFE was only associated with lower (better) BSI-18 Somatization (estimate = 0.046, p = 0.046, CI = 0.001–0.091) and BSI-18 Anxiety sub-scores (estimate = 0.053, p = 0.039, CI = 0.003–0.104) at 24–48 hours. The eAFE was not associated with days until asymptomatic, ImPACT composite scores, HADS scores, or other BSI-18 sub-scores.

Conclusions

Earlier eAFE to football was not associated with longer symptom recovery, worse cognitive performance, or greater psychological distress following concussion. Longer duration of exposure to football during childhood and adolescence appears to be unrelated to clinical recovery following concussion.

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Association between Autonomic Nervous System Function and Outcome Following Pediatric Concussion

Colt Coffman; Jacob Kay, MS; Kathryn Saba; Jeffery Holloway; Robert Davis Moore

Objective

To examine the association between heart rate variability (HRV) and pediatric concussion outcomes. We hypothesized that HRV would be related to both clinical symptoms and cognition and that HRV parameters at 2-weeks post-injury would predict outcomes at 5 weeks.

Background

Despite the growing prevalence of concussion among children, research focusing on an objective measure of recovery is lacking. Evidence suggests that dysregulation of the autonomic nervous system may be present following concussion. HRV, an objective measure of autonomic function, could prognosticate persistent symptoms following pediatric concussion.

Design/Methods

Forty-five concussed children were evaluated 2 weeks and 5 weeks post-injury. Clinical symptoms were evaluated using the Rivermead Post-Concussion Symptoms Questionnaire (RPQ). Cognition was assessed using a modified CogState Brain Injury Test Battery. Time-domain (SDNN, RMSSD, NN50) and frequency-domain (log-transformed values of low- and high-frequency power) variables of HRV were measured during a resting 5-minute recording. Key demographic and injury characteristics, as well as mean heart rate were factored as covariates.

Results

At 2 weeks post-injury, low-frequency measures showed a positive association with overall RPQ symptoms and Groton Maze Learning and Recall errors (p's < 0.05). At 5 weeks post-injury, NN50 and low-frequency measures showed a positive association with Groton Maze Learning errors (p's < 0.05). At both timepoints, time-domain and high-frequency measures showed a negative association with One-Back task accuracy (p's < 0.05). Additionally, time-domain and high-frequency measures at 2 weeks post-injury predicted One-Back task accuracy at 5 weeks post-injury (p's < 0.05).

Conclusions

Our findings support our hypothesis and indicate that HRV is associated with clinical symptoms and cognitive function post-injury. Importantly, our results also suggest that metrics of HRV collected in the acute phase may serve as a prognostic tool. Additional longitudinal research is warranted in order to replicate the current findings.

Study Supported By: This study was supported by a grant from the Research Center for Transforming Health at the University of South Carolina – given to Drs. Moore & Holloway.

Disclosures: Dr. Coffman has nothing to disclose. Dr. Kay has nothing to disclose. Dr. Saba has nothing to disclose. Dr. Holloway has nothing to disclose. Dr. Moore has nothing to disclose.

Influence of Family History of Neurodegenerative Diseases on Outcome Following Pediatric Concussion

Colt Coffman; Jacob Kay, MS; Adam Harrison; Jeffery Holloway; Robert Davis Moore

Objective

To longitudinally evaluate the relation between family history of neurodegenerative disease and clinical symptoms, as well as vestibular-ocular and cognitive outcomes following concussion in children.

Background

Research indicates that pediatric concussion may lead to chronic alterations in neuropsychological health that can adversely affect

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neurodevelopment. Therefore, it is critical to identify risk factors that may moderate recovery to improve concussion outcomes in children. Evidence suggests that one such moderator may be a family history of neurodegenerative disease (FHND).

Design/Methods

Data were collected from a local pediatric concussion clinic. Patients were examined at 2- and 5-weeks post-injury. Clinical symptoms were measured using the Rivermead Post-Concussion Symptoms Questionnaire (RPQ). Vestibular-ocular function was assessed using the Vestibular/Ocular Motor Screening (VOMS) tool. Cognition was measured using a modified CogState Brain Injury Test Battery. Log-transformations were applied to normalize data. Group differences between those with (n = 13) and without (n = 26) a family history of neurodegenerative disease (Alzheimer's, Non-Alzheimer's Dementias, Parkinson's, and/or Multiple Sclerosis) were analyzed. Children without FHND were double-matched based on sex, age, and concussion history.

Results

Across timepoints, children with FHND reported more severe clinical symptoms on the RPQ (p's < 0.05). Additionally, those with FHND showed higher VOMS saccades scores across timepoints compared to those without FHND (p's < 0.05). Further, children with FHND reported greater dizziness following VOMS saccades and convergence tests at 5-weeks post-injury (p's < 0.01). No group differences at any timepoint were observed for any measure of cognition.

Conclusions

Our findings indicate that a family history of neurodegenerative disease is associated with more severe clinical symptoms and greater vestibular-ocular dysfunction following pediatric concussion.

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Heart Rate Variability during Face Cooling in Concussed Adolescents

Mohammad Haider; Charles Wilber; Kaitlin Viera; Itai Bezherano; John Leddy, MD, FACSM, FACP

Objective

We measured heart rate variability (HRV) during physiological stimuli in acutely concussed adolescents (CX) and after clinical recovery, and compared with healthy controls (HC).

Background

Concussion is associated with autonomic dysfunction. Face Cooling (FC) triggers the trigeminal nerve to evoke transient increases in cardiac parasympathetic (PNS) activity.

Design/Methods

11 CX (14.8 ± 0.9 years, 6 male, 7 days since injury) and 11 HC (16.1 ± 1.1 years, 9 male) participated. We calculated mean heart rate (HR), standard deviation of root mean square (RMSSD, measure of PNS tone) and low-frequency to high-frequency power ratio (LF/HF ratio, measure of sympathetic [SNS] tone) at rest and 3-minute FC test.

Results

CX at Visit 1 and 2 had significantly lesser increase in HR (p = 0.02) and RMSSD (p = 0.038) than HC on FC.

Conclusions

These data show that acutely concussed participants have an attenuated PNS response to physiological stimuli which continues after clinical recovery.

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Use of a Questionnaire to Measure Concussion Knowledge in Brazilian adults

Amanda Araújo; Renata Areza-Fegyveres; Carla Guariglia, MD; Jessica Natuline Ianof; Regina Baratho; José Demario; Rafael Watanabe, MD; Renato Anghinah, MD

Objective

We aimed to evaluate the self-reported concussion knowledge of the general population, to observe and describe any gaps in the knowledge and misconceptions, and to identify the variables that influence the concussion knowledge.

Background

Concussion represents 80–90% of Traumatic Brain Injury (TBI) causes and its higher incidence is related to sports. The United States Centers for Disease Control estimates a TBI annual incidence ranging from 1.6 to 3.8 million cases, including concussions related to sport. Thus, it is seen as a public health priority. Adequate general population knowledge is a critical issue to correct diagnosis and management of concussion.

Design/Methods

We conducted a cross-sectional descriptive survey. A Concussion knowledge Questionnaire (CKQ) was created to capture data on concussion identification and causes, concussion consequences, recovery and management, and sport-related concussion The number of the sample correct and incorrect answers was calculated to measure the percent of concussion knowledge by CKQ domain.

Results

The sample was formed by 1247 Brazilian adults with a mean age of 41.7 (±11.8) years and high level of schooling. The total score in the CKQ was a mean of 20 (±10) points, which corresponds to a rate of 41.6% of correct answers. Thus, there is poor knowledge in all domains of the CKQ. Only 35.5% of correct answers were registered regarding the main symptoms of a concussion. Similarly, the higher number of incorrect answers was related to questions about recovery and management of a concussion.

Conclusions

Our study is the first to examine the concussion knowledge in a sample of Brazilian adults and provide useful information for development of concussion education programs. Our findings suggest very poor concussion knowledge in sample studied. More larger and meaningful research is needed to investigate the concussion knowledge and the variables that may interfere in the knowledge of the Brazilian general.

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An objective method to assess and recommend exertion and exercise targets for return to play post concussion

Joseph Clark; Jon Divine; Robert Mangine; Kimberly Hasselfeld; Aaron Keuhn-Himmler; Gerald Holloway; Angelo Colosimo

Objective

The object of this presentation is to supply the athletic trainer with data concerning a methodology that can be used to aid in designing a cardio conditioning regimen postconcussion as well as an exercise or lifting program postconcussion. This objective measure does not rely on subjective patient reports of symptoms and utilizes a reflex based assessment method.

Background

Sports concussion is a substantial concern for athletic trainers and there is a critical need to objectively and safely allow an athlete to return to play as soon as safely possible. Being able to make cogent recommendations as opposed to empirically trying something that has an intrinsic risk of eliciting symptoms or causing setbacks is urgently needed.

Design/Methods

We present data concerning 65 athletes (mean age 20.8 years) who were assessed. This was done while on an exercise bike going through a progression of exertion levels. The TERC Murmur was listened for every 2 minutes at the traditional carotid artery position.

Results

Results for cardio assessment. 73% of the cardio assessment subjects had a TERC Murmur at a heart rate of 127.2 bpm (± 16 SD). The transient exertion related carotid (TERC) murmur is a murmur that is heard at the carotid arteries during exercise. It normally is heard at around a heart rate of 150, but is heard a lower heart rates in concussion patients.

Conclusions

The clinical advantages of the use of the TERC murmur is that it can be applied by an athletic trainer with the training to listen for a blood pressure. It provides objective information concerning safe heart rates and target heart rate. Being able to safely recommend a means by which an athlete can condition (cardio and or lifting) will accelerate return to play as well as aid in keeping the athlete happy, healthy and engaged.

Study Supported By: NA.

Disclosures: Dr. Clark has nothing to disclose. Dr. Divine has nothing to disclose. Dr. Mangine has nothing to disclose. Dr. Hasselfeld has nothing to disclose. Dr. Keuhn-Himmler has nothing to disclose. Dr. Holloway has nothing to disclose. Dr. Colosimo has nothing to disclose.

Visual Evoked Potential and Voltage Changes Associated with Acute Concussion and Frequency Specific Photophobia

Joseph Clark; Bradley Jacobs; Kimberly Hasselfeld; Robert Mangine; James Ellis; Bret Betz; Angelo Colosimo; Jon Divine

Objective

In this paper we present a case series of concussion patients' VEP as well as a single concussion patient with a VEP baseline and post concussion VEP data.

Background

Visual Evoked Potentials (VEP) are a means of measuring the electrical behavior of the brain following a visual stimuli. The use of VEP for diagnostics following traumatic brain injury (TBI) is emerging with additional data concerning sports related concussion coming.

Design/Methods

During the 2016 spring football season there was 1 concussion of a subject who had a VEP baseline and a VEP performed during the acute phase of the concussion. Concurrently we have been using VEP for concussion patients who have not had a baseline. Fifteen subjects in the post acute phase; while symptomatic, had VEP performed using White, Red, Blue and Green for the evoked potentials.

Results

The patient with a VEP baseline had increased voltages with subtle slowing of N75 and P100. N75 increased from 67.5 msec at baseline to 75.1 msec post concussion. Voltages went from 19.3 mVolts to 24.6 mVolts post concussion. Also, the colored flashes associated with the lowest voltages were consistent with mitigation of frequency specific photophobia; 20.9 mVolts for mitigation color compared (red) to 24.6 for white. In the concussion population studied (N = 15) the voltages where the color corresponded to symptom relief were: 10.9 ± 5.7 mVolts compared to symptom evoking voltages 12.7 ± 6.3 (p = 0.0031) mVolts.

Conclusions

In this paper we present evidence of VEP changes in one acute concussion patient as well as a population of concussion patients where voltages are increased post concussion. The increased voltages associated with color VEP may be a useful technique to assess frequency specific photophobia as well as helping manage post concussion photophobia. Futures studies to assess the utility of VEP as a concussion management tool are needed.

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Observational Study of Prevention and Intervention Strategies That Help Speed Return to Play Post-Concussion in Division I College Football

Joseph Clark; Enna Selmanovic; Tyler Drewry; Robert Mangine; Aaron Keuhn-Himmler; Kimberly Hasselfeld; Jane Khoury; David Polanski; Jon Divine

Objective

We present evidence that a neurovisual oriented training program is associated with decreased concussion incidence and faster return to play (RTP) post injury in this observational cohort study.

Background

Sports concussion has been in the public eye and has been associated with heightened fear concerning playing football and other collision based sports. Protecting from concussion and rehabilitating the brain after a concussion is a high priority for many sports medical practitioners as well as for athletes wanting to play. For these reasons researchers associated with the American Athletic Conference (AAC) have been monitoring concussion incidence in football.

Design/Methods

The 12 schools of the AAC were surveyed for 2014, 2015, and 2016 concerning football induced concussions.

Results

The average seasonal concussion rate was 10.4 ± 1.02 concussions per year and average RTP time was 13.2 ± 1.21 days. In the one team where there was an aggressive neuro visual conditioning and rehabilitation post-concussion program employed the concussion rate was 3.0 ± 1.0 concussions per year and the RTP time was 6.5 ± 0.5 days. Both numbers are significantly lower than in the other AAC teams.

Conclusions

The current paper reports that there may be mitigation strategies that can be employed to decrease concussion incidence as well as aid in faster

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RTP times. Such attempts to make football safer are needed as brain injury has been associated with long term consequences. Improving safety and brain health through mitigation strategies along with rehabilitation methods may aid in keeping athletes safer during play and throughout the lifespan.

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Disclosures: Dr. Clark has nothing to disclose. Dr. Selmanovic has nothing to disclose. Dr. Drewry has nothing to disclose. Dr. Mangine has nothing to disclose. Dr. Keuhn-Himmler has nothing to disclose. Dr. Hasselfeld has nothing to disclose. Dr. Khoury has nothing to disclose. Dr. Polanski has nothing to disclose. Dr. Divine has nothing to disclose.

High Energy American Football Head Impacts to the Side and Rear Damaging Than to the Front

Adam Bartsch; Edward Benzel; Sergey Samorezov; Vincent Miele

Objective

The aim of this study was to investigate head impact doses in American football. We analyzed time-synchronized video and data collected during n = 445 player-games of American football resulting in 2851video-verified impacts. Cases where a player sustained impacts and on video was demonstrably witnessed to meet the NFL's "No-go" criteria were analyzed in-depth.

Background

In 2011, after reviewing scalar on-field kinematics data leading concussion clinicians concluded *"Recent studies suggest that a concussive injury threshold is elusive, and may, in fact, be irrelevant when predicting the clinical outcome"*.[1] It is likely that higher fidelity estimates of spatial and temporal impact parameters will clarify the currently unclear impact dose-response relationship.

Design/Methods

A total of 2851 video-verified head impacts were identified from 445 player-games. Each event was time-synchronized to video. Any events collected when the athlete was not being impacted in the head were discarded. The remaining true positive events were scrutinized based on published methods to confirm a head impact occurred in the video and the computed motion was physically realistic and matched the video.

Results

We found a median of 5 video-verified head impacts per player-game, which is far fewer than published studies without video verification.[11] For the four players with "No-go" impacts, all were to the side/rear. Coronal plane impact sensitivity has been a hypothesized clinical injury mechanism[12] and our results support that hypothesis.

Conclusions

We did not see high PLA/PAA impacts without obvious player "No-go" observations. This finding disagrees with other studies that have reported high PLA/PAA impacts without any demonstrable "No-go" observations[13]. High energy impacts to the side and rear of the head are more damaging than similar magnitude impacts to the forehead. Armed with this knowledge, clinicians should have more fidelity in their understanding of real-time impact location and severity, and how it relates to athlete concussion risk.

Study Supported By: NIH.
Disclosures: Dr. Bartsch has nothing to disclose. Dr. Benzel has nothing to disclose. Dr. Samorezov has nothing to disclose. Dr. Miele has nothing to disclose.

Male Sex Predicts Higher Depression Scores Among Healthy Collegiate Athletes

Jessie Oldham; Francis Wang; Brant Berkstresser; Corey Lanois; William Meehan, III.; David Howell

Objective

To 1) investigate differences in baseline scores on the Hospital Anxiety and Depression Scale (HADS) between male and female athletes and 2) examine the influence of concussion history on baseline HADS scores.

Background

Although post-concussion differences between sexes have been documented, whether male and female athletes differ in reporting mental health outcomes and how concussion history may influence scores remains to be fully investigated. Since athletes may experience anxiety and depression after a concussion, screening prior to the beginning of an athletic season (baseline) may identify those who are prone to post-concussion mental health disturbances.

Design/Methods

One hundred fifty-two collegiate athletes (86 males, 66 females) completed a HADS assessment during baseline testing. Each participant also reported the number of diagnosed concussions he or she previously sustained. We used independent samples t-tests to compare baseline HADS scores between male and female athletes, and a multiple linear regression to examine the relationship between baseline HADS scores, sex, and concussion history.

Results

Female athletes reported significantly lower HADS depression scores at baseline compared to males (Females: 0.92 ± 1.49, Males: 1.77 ± 2.22, F = 2.78, $p = 0.01$). There were no significant sex differences in HADS anxiety scores (Females: 4.53 ± 2.80, Males: 4.51 ± 2.84, F = 0.02, $p = 0.97$), but both sexes had higher anxiety outcomes than depression. There was an independent association between higher HADS depression scores and male sex ($\beta = -0.84$, $p = 0.01$; 95% CI = −1.47, −0.21), but not concussion history ($\beta = -0.09$, $p = 0.66$, 95% CI = −0.51, 0.33). Neither sex nor concussion history were significantly associated with HADS anxiety scores.

Conclusions

Female athletes reported lower levels of depression at baseline than males. Concussion history did not appear to influence anxiety or depression baseline scores. Psychological measures could be evaluated, both at baseline and prior to post-concussion return to play, to help identify those who may need more focused monitoring of mental health.

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No Differences in Tandem Gait Performance Between Males and Females Acutely Post-Concussion

Jessie Oldham; David Howell; Kelsey Bryk, MSc; Corey Lanois; Inga Koerte, MD, PhD; William Meehan, III.; Thomas Buckley, PhD

Objective

To examine sex differences in TG performance among collegiate student-athletes acutely post-concussion relative to pre-injury performance.

Background

Postural control impairments are common following concussion and traditionally assessed using the Balance Error Scoring System (BESS). Tandem gait (TG) has successfully identified impairments in postural control acutely post-concussion that were undetected by the BESS; thus, TG may be a more robust postural control assessment following concussion. While sex differences in BESS performance after concussion have been explored, there is no literature regarding sex differences in post-concussion TG.

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Design/Methods

Forty-eight concussed collegiate student-athletes (30 females) and twenty-five healthy controls (13 females) completed TG tests during pre-season and again acutely post-concussion. Participants walked heel-to-toe down a 3-meter line, turned, and returned as quickly as possible, completing four single-task (ST) and dual-task (DT) TG trials. During DT trials, they simultaneously answered mini-mental style questions. The best ST and DT times were recorded. A 2 × 2 (group*sex) ANOVA was used to examine TG change between pre-injury and post-injury tests (positive value = slower/worsening; negative value = faster/improving).

Results

The change in TG time from pre-injury to post-injury was significantly higher for the concussion group relative to the control group during both ST (Concussion: 1.6 ± 2.6 seconds, Controls: −1.1 ± 0.8 seconds, $p < 0.001$) and DT (Concussion: 2.0 ± 3.8 seconds, Controls: −0.9 ± 1.7 seconds, $p < 0.001$) TG. There were no significant interactions (ST: $p = 0.17$, DT: $p = 0.23$) or main effects for sex (ST: $p = 0.63$, DT: $p = 0.91$).

Conclusions

There were no sex-specific differences in TG performance acutely post-concussion. However, all concussed participants, regardless of sex, performed significantly worse on TG than male and female controls after injury relative to baseline, while controls did not demonstrate such a change. These results suggest that TG can appropriately identify postural control impairments following concussion; however, there do not appear to be differences in performance between males and females.

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Chronic traumatic encephalopathy – a study in Brazilian retired soccer players

Jéssica Natuline Lanof; Renata Areza-Fegyveres; Carla Guariglia, MD; Fábio Freire; Patrícia Nadruz; Alessandra Cerasi; Claudia Leite; Bruno Pastorello; Giovanni Guido Cerri; Renato Anghinah, MD

Objective

Evaluate the neurological, neuopsychological and electroencephalogram (EEG) findings in a cohort of retired soccer players.

Background

Chronic traumatic encephalopathy (CTE) is considered to be a consequence of exposure to repeated head traumas, but evidence suggests that a single moderate or severe traumatic brain injury can also induce progressive neuropathological changes.

Design/Methods

Prospective observational study that evaluated 26 retired soccer players and 14 controls. The retired athletes and controls were submitted to neurological evaluation, neuropsychological evaluation and EEG.

Results

In general, the soccer players performed well in tests, within the normal range. 15 soccer players had a history of previous TBI/concussion. In the retired group the average age was 60.4 years (55.7 in the CG), average of 11.7 schooling years (13.7 in the CG). The average results in MMSE was 26.6 (29 in the CG), the average digit span in backwards was 3.1 (3.8 in the CG), the average verbal fluency for animals was 15.6 (24 in the CG) and the average clock-drawing test was 8.96 (9 in the CG). Visual EEG analysis showed a predominance of posterior alpha activity between 9.0 and 12.0 Hz (mean 10.3 Hz) in the soccer participants and 11 Hz in the control group (CG). The analysis wiht low resolution electromagnetic tomography (LORETA) showed that 11 soccer players had hippocampal asymmetry (5 had less activity in the right hippocampus and 6 had less activity in the left hippocampus).

Conclusions

Although the performance of the athletes in the tests was within the normal range, the means were always inferior to those of the controls. Almost half of the players presented asymmetry in the analysis by LORETA, although visual EEG analysis was normal. This may indicate that EEG changes may be earlier and more sensitive than clinical changes. These data are preliminary and further analysis are needed.

Study Supported By: GE.

Disclosures: Dr. Lanof has nothing to disclose. Dr. Areza-Fegyveres has nothing to disclose. Dr. Guariglia has nothing to disclose. Dr. Freire has nothing to disclose. Dr. Nadruz has nothing to disclose. Dr. Derasi has nothing to disclose. Dr. Leite has nothing to disclose. Dr. Pastorello has nothing to disclose. Dr. Cerri has nothing to disclose. Dr. Anghinah; I am serving on a scientific advisory board of TORRENT Medical Company for consulting services.

Retrospective Analysis of Professional Boxing Fight Outcomes in the United States during a 6 Month Study Period in 2017

George Velasco; John Neidecker; Don Muzzi; Nitin Sethi, MD, MBBS, FAAN

Objective

To identify combatants within a population of active boxers at greater risk for morbidity and mortality by analysis of prior fight win-loss records.

Background

Prior studies have suggested that boxing losses which occur via knockout (KO) or technical knockout (TKO) are associated with greater neurological damage and higher rates of mortality among professional boxers.

Design/Methods

Professional boxing fight records were reviewed for all boxing fights that took place in the United States during a 6 month period in 2017. Fights ending in a draw or non-contest ruling were excluded. Data was collected regarding fight location, win-loss records of the participants, and final outcome of the fight (KO, TKO, judges' decision, etc).

Results

A total of 1690 professional boxing fights were included in the analysis. 46.5% (n = 786) of fights ended in a judges' decision outcome, 35.1% (n = 594) ended in TKO, 18.1% (n = 306) ended in KO, 0.2% (n = 4) ended in a participant disqualification outcome. For the subgroup of fighters with 30 + losses (n = 56), 60.7% of them lost their fights via judges' decision outcome.

Conclusions

Variability in KO/TKO rates between states may be a result of variability in pre-fight licensing requirements for fighters between different states, signaling the need for further research and implementation of interventions aimed at guiding licensure of fighters deemed to be at higher risk for injury. Boxers with greater than 30 losses on their record did not exhibit an increased likelihood of KO/TKO loss in their next fight, but still may incur significant cumulative injury and neurological damage over the course of their career. Winless boxers were at increased likelihood for losing by KO/TKO with winless fighters who had 4 losses on their record losing by KO/TKO more than 75% of the time in our study.

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Disclosures: Dr. Velasco has nothing to disclose. Dr. Neidecker has nothing to disclose. Dr. Muzzi has nothing to disclose. Dr. Sethi has nothing to disclose.

No Differences in HADS Scores Between Acutely Concussed and Healthy Collegiate Student-Athletes

Corey Lanois; Francis Wang; Brant Berkstresser; Jessie Oldham; William Meehan, III.; David Howell

Objective

To investigate differences in Hospital Anxiety and Depression Scale (HADS) scores between acutely concussed collegiate student-athletes and healthy, matched group of collegiate athletes.

Background

Mood disturbances have been documented acutely following concussion. The presence of anxiety and/or depression may complicate and prolong concussion recovery among some athletes. Therefore, it is important to examine acute post-injury anxiety and depression to facilitate proper management decisions.

Design/Methods

Twenty-six student-athletes (54% female, 19.92 ± 5.56 years of age) with a diagnosed concussion completed the HADS questionnaire within a week of injury. Twenty-six healthy student-athletes (54% female, 18.82 ± 0.54 years of age) completed the HADS during pre-season baseline testing, individually matched by sex and sport. Independent samples t-tests were used to explore differences in HADS scores between groups.

Results

There was no significant difference ($p = 0.50$) between total HADS scores of the concussion group (6.77 ± 6.17) and healthy cohort (5.81 ± 3.85). There were also no significant differences between concussion and uninjured groups on the HADS Anxiety subscale (4.38 ± 4.24 vs. 4.50 ± 2.83; $p = 0.91$) or HADS Depression subscale (2.38 ± 2.82 vs. 1.31 ± 1.67; $p = 0.10$).

Conclusions

HADS scores obtained among collegiate student athletes acutely following concussion did not significantly differ relative to matched healthy control participants. It is possible that one week post-injury was not enough time to observe measurable effects of anxiety or depression, as those are commonly seen in cases of prolonged recovery.

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Acute post-concussion anxiety and depression scores are not associated with duration of concussion symptoms among collegiate athletes

Corey Lanois; Francis Wang; Brant Berkstresser; Jessie Oldham; William Meehan, III.; David Howell

Objective

To investigate the association between acute post-injury scores on the Hospital Anxiety and Depression Scale (HADS) and symptom duration in collegiate student-athletes following a concussion.

Background

Concussion recovery as measured by symptom resolution generally occurs within a week of injury in most athletes. In some cases, however, symptoms can persist for weeks or months. Time to symptom resolution has been associated with many factors, including psychological health. Athletes with a history of psychiatric or mood disorders prior to injury may be more likely to experience prolonged symptoms. It is unknown, however, whether initial complaints of anxiety or depression following a concussion are associated with subsequent symptom duration.

Design/Methods

Twenty NCAA collegiate athletes (55% female, 20.10 ± 1.33 years) completed a HADS assessment within a week of sustaining a concussion. Participants then reported their post-concussion symptom scale daily until being cleared to return to sport. Date of symptom resolution was then collected at a follow-up assessment. Symptom duration was defined as the number of days between the injury and day of symptom resolution. Individual linear regressions were used to examine the relationship between HADS scores and symptom duration.

Results

Athletes were initially assessed at a mean of 2.65 ± 1.04 days. Mean symptom duration was 15.95 ± 17.33 days. There were no independent associations between duration of symptoms and HADS anxiety ($\beta = 0.55$, 95% CI = −1.28, 2.38, $p = 0.63$), HADS depression ($\beta = -0.21$, 95% CI = −3.08, 2.67, $p = 0.88$), or total HADS scores ($\beta = 0.23$, 95% CI = −1.07, 1.53, $p = 0.71$).

Conclusions

Post-injury anxiety and depression scores did not appear to influence symptom duration in concussed collegiate student-athletes. While mental health should continue to be monitored during recovery, duration of symptoms is likely influenced by a multifaceted set of factors that are highly variable across collegiate athletes who sustain a concussion.

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Disclosures: Dr. Lanois has nothing to disclose. Dr. Wang has nothing to disclose. Dr. Berkstresser has nothing to disclose. Dr. Oldham has nothing to disclose. Dr. Meehan III; I receive royalties from ABC-Clio publishing for the sale of the books, Kids, Sports, and Concussion: A guide for coaches and parents, and Concussions; from Springer International for the book Head and Neck Injuries in Young Athlete; and from Wolters Kluwer for working as an author for UpToDate. My research is funded, in part, by a grant from the Football Players Health Study at Harvard which is funded through the NFL Players Association and by philanthropic support from the National Hockey League Alumni Association through the Corey C. Griffin Pro-Am Tournament. Dr. Howell has nothing to disclose.

A video review of cognitive factors contributing to concussive impacts in sport

Bailey Anderson; Kaitlin Burgess; Bruno Giordani, PhD; James Eckner, MD

Objective

To explore cognitive factors contributing to concussive impacts in athletes.

Background

Cognitive training programs are becoming an increasingly popular strategy for improving athletic performance. Such programs may have potential to decrease athletes' concussion risk by improving athletes' ability to avoid and appropriately react to imminent impacts in the athletic environment. Understanding what cognitive factors contribute to concussive impacts may provide insight into the most appropriate cognitive training regimens for concussion risk reduction.

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Design/Methods

YouTube videos depicting 100 concussive impacts in athletes were identified via Google video search. Two reviewers independently classified the primary cognitive factor contributing to each impact as one of the following: useful field of view (UFOV, unanticipated/unrecognized impacts coming from outside the athlete's field of view), field dependence (FD, unanticipated/unrecognized impacts resulting from the athlete's attention being so focused on an athletic task that the pending impact was not recognized), processing speed (PS, anticipated/recognized impacts occurring too quickly for the athlete to complete an evasive or protective maneuver), or motion perception (MP, anticipated/recognized impacts occurring with sufficient time to respond but associated with a poorly planned or implemented motor response). Descriptive statistics were calculated.

Results

98 videos were reviewed to yield 100 concussive impacts. 98% of the concussed athletes were males. Concussions occurred during American football (53%), ice hockey (29%), soccer (3%), basketball (3%), as well as 9 other sports (12%). The most commonly contributing cognitive factor was MP (32%), followed by FD (30%), UFOV (23%), and PS (15%).

Conclusions

Multiple cognitive factors contribute to concussive impacts in athletes, with MP and FD being the most common in our sample. Cognitive training programs intending to reduce concussion risk in athletes should not focus only on one cognitive factor. Future work should also explore differences between sports and positions.

Study Supported By: NA.
Disclosures: Dr. Anderson has nothing to disclose. Dr. Burgess has nothing to disclose. Dr. Giordani has nothing to disclose. Dr. Eckner has nothing to disclose.

Influence of Learning Disabilities on the Neurophysiological and Neuropsychological Health in Athletes with a History of Concussion

Adam Harrison; Veronik Sicard; R. Davis Moore, PhD

Objective

The aim of present study was to investigate the role of LD on neuropsychiatric and neurophysiological recovery following concussion.

Background

It is estimated that roughly 20% of athletes suffer from a neurodevelopmental disorder (ND). Although concussion research has primarily focused on attention deficit hyperactivity disorder (ADHD), the influence of other NDS, such as learning disorder (LD) on concussion outcomes remains relatively unknown.

Design/Methods

Seventy-five athletes (24 healthy control, 24 concussed, and 27 concussed-LD) completed a neuropsychiatric and neurophysiological test battery; including the Beck Depression Inventory (BDI), profile of mood states (POMS), and modified CogState Brain Injury Test battery. Additionally, event-related potentials were recorded during an experimental odd ball task. All athletes were matched based on age, education, BMI, and sport played. Athletes with a history of concussion were further matched on time since injury and number of previous injuries.

Results

Concussion-LD athletes reported significantly greater depressive symptoms compared to matched concussed and healthy control athletes ($p < 0.05$). When decomposed, the group differences in depressive symptoms were driven by cognitive and affective depression sub-scales ($p's < 0.05$), not somatic depression ($p > 0.05$). Additionally, concussion-LD athletes demonstrated greater cognitive deficits characterized by increased learning errors and decreased working memory ($p's < 0.05$). Furthermore, neurophysiological analyses revealed that Concussed-LD athletes exhibited significantly delayed P3b latency ($p < 0.05$). Finally, irrespective of LD status, athletes with a history of concussion reported increased overall mood disturbances, as well as ratings of anger and hostility compared to controls ($p < 0.05$).

Conclusions

Our results suggest that athletes with concussed athletes with LD may exhibit chronic neuropsychiatric and neurophysiological deficits beyond that of their concussed counterparts (without LD). Further research is needed to better understand the relationship between LD and concussion outcomes.

Study Supported By: NA.
Disclosures: Dr. Harrison has nothing to disclose. Dr. Sicard has nothing to disclose. Dr. Moore has nothing to disclose.

Recovery Profiles Following Concussion Among Male Athletes with a Family History of Neurodegenerative Disease: Data from the NCAA-DOD CARE Consortium

Adam Harrison; Steven Broglio, PhD; R. Davis Moore, PhD; Andrew Lapointe; Michael McCrea, PhD

Objective

Longitudinally assess recovery following concussion in male athletes with fhNDD.

Background

Research suggests that a family history of neurodegenerative disease (fhNDD) may predispose an athlete to abnormal recovery following brain injury. However, no one has longitudinally assessed recovery following concussion in male athletes with fhNDD.

Design/Methods

Data from the NCAA-DOD Grand Alliance: Concussion Assessment, Research, and Education (CARE) Consortium were used to compared male athletes with (n = 51) and without (n = 102) a family history of neurodegenerative disease (Parkinson's, Alzheimer's, Non-Alzheimer's Dementia, and Mild Cognitive Impairment). All athletes completed baseline ImPACT assessments prior to the beginning of their sporting season. Athletes that sustained a concussion were then re-evaluated 24-48 hours post-injury, prior to un-restricted return to play (RTP), and again 6 months post-injury. Athletes without fhNDD were double matched based on age, body mass index, sport category, and concussion history.

Results

Repeated measures ANCOVA models were used to evaluate performance at each post-injury timepoint, while controlling for baseline performance. A group × time interaction was observed for visual memory performance. Post-hoc univariate analyses revealed that male athletes with fhNDD demonstrated significantly poorer visual memory performance 24–48 hours post-injury compared to controls ($p \leq 0.005$). Additionally, we found a main effect of group for impulse control, indicating that male athletes with fhNDD demonstrated an increase number of impulse errors at all three post-injury evaluations ($p \leq 0.004$). We did not to observe any other group differences ($p's > 0.05$).

Conclusions

Our results suggest that male athletes with a family history of neurodegenerative disease may exhibit greater post-injury cognitive deficits compared to controls. Additionally, some deficits may persist for at least 6 months post-injury. Further research is warranted to investigate the interaction between family history of neurodegenerative disease and concussion.

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Baseline Cardiorespiratory Function in Youth with Persistent Post-Concussion Symptoms

Aliyah Snyder, PhD; Meghan Patel; Christopher Sheridan; Alexandra Tanner; Douglas Polster, PhD; Talin Babikian; Michelle Craske; Meeryo Choe, MD; Christopher Giza, MD, FAAN; Robert Asarnow

Objective

To evaluate cardiorespiratory functions in youth with persistent post-concussion symptoms compared to controls and to examine the predictive value of relevant demographic and medical variables.

Background

Recent studies propose that persistent post-concussion symptoms (PPCS) (e.g., headache, fatigue, or dizziness; lasting >2 months post injury) may be linked to autonomic dysregulation, initially provoked by injury but then maintained by biopsychosocial factors during recovery (i.e., pain sensitivity, behavioral avoidance of symptom triggers, worries, etc). One way that autonomic dysregulation can be detected is through monitoring cardiorespiratory dynamics such as end-tidal CO_2 fraction ($ETCO_2$), respiratory rate (RR), oxygen saturation (PsO_2) and pulse rate (PR). However, the few studies measuring cardiorespiratory outcomes in concussion are restricted to the acute stage of injury. Therefore, the present study sought to examine 1) cardiorespiratory functioning in youth patients with PPCS and 2) the relationship of relevant demographic and medical variables to these outcomes.

Design/Methods

Participants between the ages of 13-25 were recruited into two groups: 1) n = 7 patients diagnosed with concussion and PPCS (2-9 months post-injury) and 2) n = 7 non-injured controls. Data ($ETCO_2$, RR, PsO_2, & PR) were collected using a capnometer during a 5-minute passive recording session.

Results

At rest, patients' $ETCO_2$ measurements were significantly lower than controls ($p = .04$) with a large effect size ($d = 1.22$). Besides injury status, the only significant medical or demographic variable was positive family history of anxiety, which predicted lower $ETCO_2$ ($p = .04$; $d = 1.35$). Of note, personal history of anxiety disorder was not significantly correlated with $ETCO_2$.

Conclusions

PPCS patients appear to have $ETCO_2$ concentration below the normal range at baseline (i.e., rest), supporting the theory that disrupted autonomic regulation in this population is related to persistent symptoms. Importantly, autonomic dysregulation as measured through cardiorespiratory functioning could represent a promising treatment target for PPCS patients.

Study Supported By: UCLA Brain Injury Research Center, UCLA Steve Tisch BrainSPORT Program, UCLA Easton Labs for Brain Injury, Stan and Patty Silver, NINDS NS09229.
Disclosures: Dr. Snyder has nothing to disclose. Dr. Patel has nothing to disclose. Dr. Sheridan has nothing to disclose. Dr. Tanner has nothing to disclose. Dr. Polster has nothing to disclose. Dr. Babikian has nothing to disclose. Dr. Craske has nothing to disclose. Dr. Choe has received research support from Neural Analytics. Dr. Giza has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Highmark Interactive. Dr. Giza has received research support from Avanir, Neural Analytics. Dr. Asarnow has nothing to disclose.

History of Concussion and Nonfatal Suicidal Behaviors in U.S. High School Students: Findings from the 2017 National Youth Risk Behavior Survey

Jacob Kay, MS; Colt Coffman; R. Davis Moore, PhD

Objective

To examine the association between concussion history and suicidal behaviors in adolescents from the 2017 National Youth Risk Behavior Survey (YRBS).

Background

Research indicates that behavioral changes such as impulsivity and lack of emotional control are common following youth concussion. Additional evidence suggests that poor behavioral regulation may contribute to altered mood states that precede possible self-injury or fatality. To date, the relation between adolescent concussion and suicidal behaviors has not been explored on a national scale.

Design/Methods

Data from 14,765 high school students were cross-sectionally analyzed. Weighted multivariate logistic regressions were conducted to estimate adjusted odds ratios (AOR) and 95% confidence intervals (CI) of suicidal behaviors in students with and without a history of concussion. Age, sex, and alcohol use were controlled for in the regression model.

Results

Adolscents with history of concussion were at greater odds of reporting suicidal ideation (AOR = 1.39, CI 1.16, 1.65), suicide planning (AOR = 1.34, CI 1.14, 1.57), suicidal attempts (AOR = 1.68, CI 1.36, 2.09), and injurious suicidal attempts (AOR = 2.42, CI 1.82, 3.22). In addition, females with a history of concussion demonstrated greater odds of reporting poor mental health than males with history of concussion (p's < 0.05). Further, history of concussion among individuals aged 16 years or older was significantly associated with increased suicidal behaviors, whereas this association was not observed in younger adolescents (p's < 0.05).

Conclusions

Our findings indicate that adolescents who sustain a concussion have greater odds of suicidality than their uninjured counterparts. Further, suicidality was better predicted by concussion exposure in females than males, and in older students. Consequently, these results indicate the importance of examining mental health following youth concussion, and highlight the need for further longitudinal research.

Study Supported By: The YRBS is conducted by the Centers for Disease Control and Prevention and provides open-access to data representative of 9th through 12th grade students in public and private schools across the United States.
Disclosures: Dr. Kay has nothing to disclose. Dr. Coffman has nothing to disclose. Dr. Moore has nothing to disclose.

The Influence of Hormonal Contraceptives on Cognitive Recovery in Concussed Collegiate Athletes: Data from the NCAA-DoD CARE Consortium

Jacob Kay, MS; Andrew Lapointe; Thomas McAllister, MD; Michael McCrea, PhD; Steven Broglio, PhD; R. Davis Moore, PhD

Objective

To longitudinally examine the relation between hormonal contraceptives and concussion recovery. We hypothesized that female athletes using hormonal contraceptives would exhibit faster recovery times and smaller post-injury alterations in neurological status, cognition, and clinical symptoms than female athletes not using hormonal contraceptives.

Background

Research indicates sex may moderate concussion outcomes, with some females experiencing protracted recovery relative to males. It is

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hypothesized that fluctuations of sex hormones lead to poorer outcomes in these females. Thus, female athletes taking hormonal contraceptives may exhibit better recovery than their un-medicated counterparts, as their hormone levels are artificially stabilized.

Design/Methods

Data from the NCAA-DOD Grand Alliance: Concussion Assessment, Research, and Education (CARE) Consortium were used to evaluate female athletes who were (n = 50) and were not (n = 50) taking hormonal contraceptives. Baseline assessments were completed prior to athletes' sport season. Athletes were re-assessed 24–48 hours post-concussion, and again at the unrestricted return-to-play. Length of recovery was defined as days between injury and the unrestricted return-to-play. Neurological status was measured using the Standardized Assessment of Concussion (SAC). Cognitive function and clinical symptoms were measured using the ImPACT test. Participants were matched on age, sex, body mass index, sport, and concussion history.

Results

No group differences in length of recovery were observed ($p > 0.05$). Across all timepoints, analyses revealed main effects of group for concentration (SAC; $p = 0.04$), verbal memory (ImPACT; $p = 0.03$), and cognitive efficiency (ImPACT; $p = 0.01$). No differences in change scores (relative to baseline) were observed between groups.

Conclusions

The current results suggest that hormonal contraceptives do not influence concussion recovery. However, irrespective of injury status, our findings indicate that females on hormonal contraceptives may exhibit better concentration, working memory, and cognitive efficiency.

Study Supported By: The NCAA-DOD Grand Alliance Concussion Assessment, Research and Education (CARE) Consortium.
Disclosures: Dr. Kay has nothing to disclose. Dr. Lapointe has nothing to disclose. Dr. McAllister has received research support from NCAA, Department of Defense. Dr. McCrea has nothing to disclose. Dr. Broglio has nothing to disclose. Dr. Moore has nothing to disclose.

Cardiorespiratory Stress-Response in Youth with Persistent Post-Concussion Symptoms

Aliyah Snyder, PhD; Meghan Patel; Christopher Sheridan; Alexandra Tanner; Douglas Polster, PhD; Talin Babikian; Michelle Craske; Meeryo Choe, MD; Christopher Giza, MD, FAAN; Robert Asarnow

Objective

To evaluate cardiorespiratory response to a cognitive/emotional stressor in youth with persistent post-concussion symptoms (PPCS).

Background

The mechanisms of PPCS (symptoms lasting > 2 months) are poorly understood, but recent studies have emphasized the interactive effect of biopsychosocial factors during recovery. In particular, emerging evidence points to anomalies in autonomic functioning as a key player in PPCS. Autonomic functioning is best measured under conditions of stress; however, there are no current studies that examine autonomic functioning in response to cognitive/emotional stressors in youth with PPCS. Therefore, the present study sought to examine the autonomic response to a cognitive/emotional stressor as measured by a cardiorespiratory outcome (end-tidal CO_2 fraction [$ETCO_2$]) as well as cognitive performance metrics in youth with PPCS.

Design/Methods

Participants included 7 patients diagnosed with concussion and 7 non-injured controls between the ages of 13–25. Participants were administered a modified version of the Paced Auditory Serial Addition Test (PASAT), a neuropsychological task that is known to induce autonomic arousal. $ETCO_2$ data were collected via continuous capnometry recording throughout the task and for 10 minutes after.

Results

After the PASAT, PPCS patients' $ETCO_2$ concentration remained stable over the 10' post-stress period compared to controls who demonstrated a significant increase in $ETCO_2$ ($p < 0.05$) after the cognitive/emotional stressor. In general, patients with PPCS performed more poorly on the middle trials of the PASAT compared to controls but comparisons were not significant.

Conclusions

PPCS patients demonstrate abnormal cardiorespiratory functioning following a cognitive/emotional stressor in that their $ETCO_2$ concentrations remain chronically low after stress. Results suggest autonomic dysregulation is a promising avenue for future research into the etiology of PPCS.

Study Supported By: UCLA Brain Injury Research Center, UCLA Steve Tisch BrainSPORT Program, UCLA Easton Labs for Brain Injury, Stan and Patty Silver, NINDS NS09229.
Disclosures: Dr. Snyder has nothing to disclose. Dr. Patel has nothing to disclose. Dr. Sheridan has nothing to disclose. Dr. Tanner has nothing to disclose. Dr. Polster has nothing to disclose. Dr. Babikian has nothing to disclose. Dr. Craske has nothing to disclose. Dr. Choe has received research support from Neural Analytics. Dr. Giza has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Highmark Interactive. Dr. Giza has received research support from Avanir, Neural Analytics. Dr. Asarnow has nothing to disclose.

The efficiency of the King-Devick Test for detecting concussion in a youth athlete population

Jennifer Adler; Amaal Starling, MD; Jamie Bogle, PhD; David Dodick, MD, FAAN; Jennifer Wethe, PhD

Objective

1) To investigate the efficiency of the King-Devick Test (KDT) as a screening tool for concussion in a pediatric collision-sport population prone to concussion 2) to examine the accuracy of the KDT when administered by trained laypersons.

Background

The KDT is an efficient sideline assessment tool for sport-related concussion (Howitt et al., 2016). KDT has been shown to be sensitive to the effects of concussion, reliable, and easy to use and interpret (Echemendia et al. 2017). There are rarely medical professionals on the sideline of youth events and the KDT has effectively been administered by laypersons in a cohort of amateur boxers (Leong, et al., 2013).

Design/Methods

32 sideline KDT evaluations (21 possible concussions; 11 controls; 3 excluded due to inability to confirm concussion diagnosis) of 28 collision sport athletes (1 female) aged 7 to 15 were conducted. Sideline KDT time was compared to baseline KDT time to determine pass or fail (>1 second longer = fail). Sensitivity and specificity for KDT were calculated to determine KDT ability to identify concussion. Medical professional identification of concussion = concussion diagnosis. 10 concussions were identified. Further analysis evaluated sensitivity and specificity of KDT based on who conducted sideline evaluation (layperson n = 10).

Results

The overall sensitivity was 80% and specificity was 89.5%. When administered by a layperson, sensitivity was 100% and specificity was 80.0%.

Conclusions

In this small study, KDT was helpful for detecting the presence of concussion and correctly identifying individuals without concussion. KDT

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should be added to sideline concussion screening in a pediatric population prone to concussion. Ideally, medical professionals should be present; however, when administered by laypersons, the KDT yielded excellent sensitivity and adequately identified those without concussion supporting its effective administration by trained laypersons as a practical screening tool.

Study Supported By: NA.
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Multidisciplinary Therapy for Persistent Post-Concussion Symptoms: A Case Series from the UCLA Steve Tisch BrainSPORT Clinic

Christopher Sheridan; Aliyah Snyder, PhD; Douglas Polster, PhD; Madison Harris, OTR/L; Rafael Romeu-Mejia; Tara Sharma, DO; Talin Babikian; Meeryo Choe, MD; Christopher Giza, MD, FAAN

Objective

To examine the effectiveness of a six-session multidisciplinary intervention of coordinated cognitive behavioral therapy (CBT) and programmed aerobic exercise for patients suffering from persistent post-concussion symptoms (PPCS) as measured via a battery of validated patient-reported assessments.

Background

Between 10–30% of patients who suffer a concussion continue to experience elevated symptoms for a period lasting three months or longer post-injury. PPCS presentations are heterogeneous with respect to symptom domain, and while there are currently no clear evidence-based guidelines for treatment, emerging evidence suggests that multidisciplinary care incorporating medical management of symptoms, CBT, and aerobic exercise may be more effective than medical management alone.

Design/Methods

Patients in this case series (n = 7, female = 6, age = 26.9 ± 13.0) were referred to therapy from a concussion outpatient clinic. Patients completed a course of CBT and programmed aerobic exercise comprising six in-person sessions and prescribed CBT and aerobic exercise homework to be completed between sessions. Adherence was tracked and outcomes were measured via change in self-reported scores on the Beck Anxiety Inventory (BAI), Beck Depression Inventory II (BDI-II), Brief Illness Perception Questionnaire (Brief-IPQ), Pain Catastrophizing Scale (PCS), Pediatric/Adult Quality of Life (PedsQL), Pittsburgh Sleep Quality Index (PSQI), and Post-Concussion Symptom Inventory (PCSI).

Results

All patients completed a full course of therapy and prescribed homework. Significance was defined as $p < 0.05$. Patients showed significant improvement in PSCI total score ($p = 0.026$; d = −1.115) and improvement trending toward significance in BDI-II ($p = 0.075$; d = −0.842), PCS ($p = 0.087$; d = −0.484), and PedsQL ($p = 0.089$, d = 0.593).

Conclusions

A relatively short multidisciplinary intervention may alleviate symptom burden and improve quality of life in PPCS patients and deserves more systematic study.

Study Supported By: UCLA Brain Injury Research Center, UCLA Steve Tisch BrainSPORT Program, UCLA Easton Labs for Brain Injury, Stan and Patty Silver.
Disclosures: Dr. Sheridan has nothing to disclose. Dr. Snyder has nothing to disclose. Dr. Polster has nothing to disclose. Dr. Harris has nothing to disclose. Dr. Romeu-Mejia has nothing to disclose. Dr. Sharma has nothing to disclose. Dr. Babikian has nothing to disclose. Dr. Choe has received research support from Neural Analytics. Dr. Giza has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Highmark Interactive. Dr. Giza has received research support from Avanir, Neural Analytics.

The utility of Matrix Reasoning as an embedded performance validity indicatory in youth athletes

Jennifer Adler; Ryan Thompson; Naomi Kaswan; Rayna Hirst

Objective

The present study assessed Matrix Reasoning (MR) as an embedded validity indicator (EVI) in youth athletes vulnerable to sport-related concussion, using performance on the Test of Memory Malingering (TOMM) to operationalize effort.

Background

Matrices tasks have been examined as EVI for pediatric neropsychological assessment (NA; McKinsey, Prieler, & Raven, 2003), and recent literature suggests a cutoff T-score of 43 for MR in the Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II) may demonstrate utility within youth athletes completing baseline NA.

Design/Methods

103 youth athletes (76% male, M_{age} = 12.14) completed a NA, including MR (cutoff T = 43) and TOMM (cut-offs = 45 and 49). Sensitivity and specificity for MR were calclated. Reciever operator characteristics (ROC) curve analysis determined whether MR performance accurately categorized participants' effort (represented by TOMM performance).

Results

MR (cut-off T = 43; Sussman et al., 2019) produced sensitivity of 9.09% and specificity of 91.36% in predicting TOMM Trial 1 performance (TOMM1; AUC = 0.449) and 0.00% and 91.18% in predicting TOMM Trial 2 (TOMM2; AUC = 0.074). As a TOMM2 cut-

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off of 49 offers greater sensitivity to inadequate effort, a further analysis showed MR yielded sensitivity of 0.00% and specificity of 91.00% (AUC = 0.330) in predicting TOMM2 performance with the more conservative cutoff.

Conclusions

MR is an adequate EVI in predicting sufficient effort on TOMM, detecting true effortful performance; however, it was inadequate in detecting true non-effortful performance. A more stringent TOMMM cutoff did not improve sensitivity; thus, MR exhibited poor detection of inadequate effort. Overall, MR has utility as an EVI to support adequate effort in youth athlete populations but should not be used independently. This finding is clinically important because adequate effort at baseline is imperative in determining recovery from concussion.

Study Supported By: NA.
Disclosures: Dr. Adler has nothing to disclose. Dr. Thompson has nothing to disclose. Dr. Kaswan has nothing to disclose. Dr. Hirst has nothing to disclose.

Concussion and Court: The Role Litigation Plays in Time to Recovery

Jennifer McVige, MD; Dilpreet Kaur; Michael Lillis; Brianna Albert; Kabir Jalal

Objective

To evaluate whether there is a difference in time to recovery (TTR) between concussion patients who have and have not pursued litigation post injury, and determine what factors might influence someone's decision to litigate.

Background

An investigation on how litigation influenced TTR in all types of recovery.

Design/Methods

A retrospective study of 851 adult and pediatric patients, ages 1–78 (333men and 518 women) in a concussion clinic. Injuries included, motor vehicle accidents MVA (n = 181), falls (n = 140), assaults (n = 36), sporting injuries (n = 378) and other (n = 116). Full and matched samples were studied by symptom endorsement, (headache, dizziness, sleep disturbance, attention/concentration dysfunction and moodiness), litigation/non-litigation and TTR (survival-curve). Secondary analysis reviewed abuse/depression, mechanism-of-injury and symptom type as it related to litigation/non-litigation.

Results

1) The odds ratio (OR) in the logistic regression model for the unmatched sample shows increasing age, fewer total symptoms (<3 symptoms vs. ≥3), history of abuse/depression, and mechanism-of-injury as significant predictors of litigation status. MVA, compared to sports/other injuries, showed the greatest rates of litigation (OR = 98.121). Higher total symptoms showed increased litigation (OR = 0.238), where abuse/depression patients are less likely to pursue litigation (OR = 0.063/OR = 0.214). 2) A survival analysis of unmatched patients suggested that patients engaging in litigation have a longer TTR (Litigation TTR M = 293 days vs. non-litigation TTR M = 130 days). However, a matched analysis, which grouped patients by age, #of symptoms, abuse/depression history, and mechanism-of-injury, showed no significant difference in survival time between patients based on litigation status. (Litigation TTR M = 269 days vs. non-litigation TTR M = 223 days).

Conclusions

While litigation patients are often stereotyped to malinger and exaggerate symptoms, this data showed that with appropriate matched analysis, there was no difference between litigation/non-litigation patients with TTR. The desire to pursue litigation may be influenced by several factors; athletes were less likely to litigate. These findings are important for physicians and attorneys to consider when tasked with focusing on recovery time in litigation cases.

Study Supported By: Dent Family Foundation.
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Transient perturbation in neuro-ophthalmologic function after repetitive subconcussive head impacts: a randomized controlled trial

Keisuke Kawata; Madeleine Nowak; Zachary Bevilacqua; Keisuke Ejima; Megan Huibregtse; Timothy Mickleborough; Sharlene Newman

Objective

To examine the effect of subconcussive head impacts on neuro-ophthalmologic function tested by the King-Devick test (KDT).

Background

Subconcussive head impacts can lead to insidious neurological impairment if sustained repetitively. The oculomotor system is sensitive to brain trauma; however, neuro-ophthalmologic response to subconcussive head impacts remain unclear.

Design/Methods

Sixty-eight healthy adult soccer players with at least 5 years of soccer heading experience were randomized into either a soccer heading group (n = 36) or soccer kicking-control group (n = 32). The independent variables were group (heading vs. kicking control) and assessment time points (pre-, 0 hr-, 2 hr-, and 24 hr-post-heading/kicking). At each time point, KDT performance was assessed. Between the pre and 0hr post time points, heading subjects then performed 10 soccer headers, with the ball traveled at 25 mph, over the course of 10 minutes. The control subjects kicked the soccer ball 10 times.

Results

The heading group experienced a median linear head acceleration of 31.8*g* per head impact (IQR: 31.1–34.5*g*) and a median rotational head acceleration of 3.56 krad/sec^2 per head impact (IQR: 2.93–4.04 krad/sec^2). Conversely, soccer kicks did not result in a detectable level of head acceleration. The kicking control group showed a significant improvement in KDT performance over time, indicating the neuro-ophthalmologic adaptability and learning effect (pre, 42.5 ± 5.7 sec; 0 hr-post, 39.3 ± 5.9 sec; 2 h-post, 38.5 ± 5.8 sec; 24 h-post, 37.3 ± 6.1 sec). However, such improvement was blunted by repetitive soccer headings in the heading group (pre, 43.6 ± 7.8 sec; 0 hr-post, 42.7 ± 7.9 sec; 2 h-post, 42.6 ± 7.8 sec; 24 h-post, 40.7 ± 7.3 sec), as illustrated by significant time × group interactions at 0 hr (p = 0.012) and 2 hr (p = 0.002) post-heading/kicking time points in the mixed-effect regression model.

Conclusions

Our data suggest that the neural circuit encompassing the brain and oculomotor system has tremendous abilities to adapt and improve its function if administered repeatedly, but subconcussive head impacts induced by soccer heading can transiently impair neuro-ophthalmologic function and its adaptive property.

Study Supported By: Indiana State Department of Health.
Disclosures: Dr. Kawata has nothing to disclose. Dr. Nowak has nothing to disclose. Dr. Bevilacqua has nothing to disclose. Dr. Ejima has nothing to disclose. Dr. Huibregtse has nothing to disclose. Dr. Mickleborough has nothing to disclose. Dr. Newman has nothing to disclose.

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Concussion History, Career Status and Cumulative Years of Football Exposure Influence Concussion Assessment Performance in Elite Football Players

Brittani Cookinham; Chad Swank, PhD; Mark Weber; Ann Medley; Kelli Brizzolara

Objective

To explore relationship of concussion history, career status, and cumulative years of contact football exposure on total symptoms, symptom severity, neurocognitive function, and balance in elite football players.

Background

61% of retired football players report sustaining a concussion during their professional career. However, the influence of concussion history, career status and cumulative years played on total symptoms, symptom severity, neurocognitive function, and balance is largely unexplored.

Design/Methods

Elite football players (n = 102; age M = 27.75 ± 6.95 years) without a concussion (>30 days) underwent SCAT-3 assessments. Players were placed into a low (0–1) or multiple concussion (2+) history group and categorized by career status (draft prospects, active professional players and retired professional players). Data were analyzed using negative binomial regression and multiple linear regression analyses.

Results

58.8% of players reported symptoms. Most common symptoms were fatigue (33.3%), trouble falling asleep (31.4%), difficulty remembering (29.4%), and difficulty concentrating (20.6%). Multiple concussions group reported 3.07 times greater total symptoms (p < 0.001), 3.58 times higher symptom severity (p < 0.001), and lower SAC scores (1.42 points) (p = 0.033) compared to low concussion group. Professionals reported 1.88 times greater total symptoms (p = .038) and 2.35 times higher symptom severity compared to draft prospects (p = 0.001). Retired players reported 7.07 times greater total symptoms (p < 0.001), 8.97 times higher symptom severity (p < 0.001), lower SAC scores (1.98 points) (p = 0.025), and 3.67 more m-BESS errors (p = 0.002), compared to draft prospects. Players with 11–19 years football exposure reported 3.83 times higher symptom severity compared to players with <11 years football exposure (p = 0.001). Players with >19 years football exposure had 6.87 times higher symptom severity than players with <11 years football exposure (p < .001).

Conclusions

Retired players with multiple concussions and 19+ years of contact football exposure are likely to have more symptoms, higher symptom severity, and lower neurocognitive scores.

Study Supported By: Texas Woman's University.
Disclosures: Dr. Cookinham has nothing to disclose. Dr. Swank has nothing to disclose. Dr. Weber has nothing to disclose. Dr. Medley has nothing to disclose. Dr. Brizzolara has nothing to disclose.

Outcomes of Multidisciplinary Care for Pediatric Post-Concussive Symptoms

Jillian O'Neil; Sean Rose, MD; Ashley Davidson; Kathleen Shiplett; Anthony Castillo; Kelly McNally

Objective

To evaluate the effectiveness of a multidisciplinary treatment approach for adolescents experiencing prolonged recovery from concussion.

Background

Although most youth recover from a concussion within 2–4 weeks, an estimated 14% of those injured remain symptomatic at 3 months post-injury. For those experiencing protracted recovery, the 2017 Berlin Concussion in Sport Group Consensus Statement recommends multidisciplinary collaborative care. While recent research utilizing progressive aerobic exercise among adolescents with concussion has shown promise for reduction in symptom burden, limited evidence exists for multidisciplinary care.

Design/Methods

Participants included 39 adolescents (77% female, 87% Caucasian) referred to the Nationwide Children's Hospital Complex Concussion Clinic. All patients included had persistent (≥30 days post-injury) post-concussion symptoms (SCAT-5 symptom score ≥10). The sample ranged in age from 11-20 years (mean = 15.0, SD = 2.0) and median days since injury was 60 (range = 30–161). 31% of participants had a history of one or more previous concussions, 54% had a history of anxiety or depression, and 26% had a history of ADHD or a learning disorder. The multidisciplinary treatment included sessions with Neurology (mean number of sessions = 2.5), Neuropsychology (mean = 2.1), Physical Therapy (mean = 3.6), and Athletic Training sessions involving graded physical exercise (mean = 4.0), with an average treatment duration of 57.4 days. SCAT-5 symptom rating scales were completed at each visit.

Results

Symptom burden among participants significantly decreased between their initial visit (mean = 49.6, SD = 19.2) and final exercise session (mean = 12.8, SD = 14.1); p < 0.001. Gender did not predict symptom ratings at treatment onset, though males (mean = 5.6) had significantly lower symptom scores than females (mean = 15.0) at their final visit (p < 0.05). Demographic factors and premorbid psychological history did not predict rate of symptom improvement.

Conclusions

High rates of premorbid psychological problems are evident in children referred for treatment of PCS. Multidisciplinary care involving graded aerobic exercise and psychological intervention shows promise, though specific factors associated with treatment response remain to be elucidated.

Study Supported By: Nationwide Children's Hospital Department of Pediatric Psychology and Neuropsychology.
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Determining Near Point of Convergence: An Exploration of One Component of the Vestibular/Ocular Motor Screen Compared to Varied Target Sizes

John Duane Heick; Curt Bay, PhD, AT

Objective

Sport-related concussions are considered a public health issue due to the number of athletes who sustain concussions.

Background

The Vestibular Ocular Motor Screening (VOMS) Assessment appears to be useful in evaluating concussion. Investigators have reported that abnormal near point of convergence (NPC), a component of the VOMS, is associated with prolonged concussion recovery. The purpose of this study was to compare four commonly used approaches to estimating NPC.

Design/Methods

Four methods of measuring NPC were evaluated (tip of a pen, 12-point font, 14-point font, and the Bernell Vergel™ 9-point font). A generalized

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estimating equations approach was used to compare NPC measurements with the four methods, employing one practice trial, followed by three test trials. A sequential Bonferroni adjustment was used for pairwise comparisons. NPC estimate was modestly correlated with age of the subject, so age was included as a covariate. Significance was set at $p = 0.05$, a priori.

Results

Seventy-five healthy adults (16 males, 59 females; mean age, 21 ± 6.12 years, range, 18-58 years) were tested. The mean (standard error) for NPC was 7.13 ± 0.36 (95% CI, 6.45, 7.88). The smaller targets (Bernell Vergell™ and pen) yielded significantly larger estimates of NPC than both the 12- and 14-point font targets, $p < 0.001$). The Bernell Vergell™ and pen NPC did not differ ($p = 0.134$), and the 12- and 14-point font NPC's did not differ ($p = 0.794$).

Conclusions

Evaluation of NPC in the clinical environment uses non-standardized items of convenience that vary in size. The results of this study suggest that size is an important consideration when measuring NPC. Multiple disciplines are investigating NPC because of its relationship with concussion. Using evidence-based assessment tools such as the VOMS requires a systematic approach. Precision is required in clinical assessment, so it is suggested that clinicians use one standard approach to estimate NPC.

Study Supported By: NA.
Disclosures: Dr. Heick has nothing to disclose. Dr. Bay has nothing to disclose.

Hyperactive behavior of athletes with post-concussion symptoms

Ingo Helmich, PhD; Lausberg Hedda

Objective

Observations of hyperactive (/restless, agitated) behavior as a consequence of sport related concussions (SRC) are inconclusive as hypoactivity has also commonly been described. This might be grounded in the fact that the movement behavior of athletes has not been systematically investigated during standardized settings and with objective methods of movement analysis.

Background

Thus, we investigated the contradiction whether symptoms after SRC are characterized by a hyper- or hypoactive movement behavior experimentally.

Design/Methods

Three matched groups were investigated: 14 symptomatic and 14 asymptomatic athletes with a concussion; and 12 non-concussed athletes. Four certified raters analyzed with the NEUROGES the Activation and Contact incl. Rest/Pose categories as reliable measures of hypo/hyperactivity of (hand) / body movement activity that were displayed during a videotaped standardized anamnesis protocol.

Results

Symptomatic athletes spend significantly more time with act apart hand movements and less time with closed rest positions when compared to non-concussed athletes. Post-concussion symptom (PCS) scores positively correlate with act apart hand movements. A linear regression analysis revealed that act apart hand movements significantly predict the PCS score.

Conclusions

In line with previous descriptions of hyperactivity after SRC, athletes with increased symptoms after mTBI in sports behave hyperactive and restless when analyzed systematically. Because agitated/restless behavior was previously described in the concussed athletes who were later diagnosed with chronic traumatic encephalopathy (CTE), we suggest that future diagnoses should concern the detailed analysis of the movement activity as a potential behavioral marker of sport related concussions.

Study Supported By: University research funding of the German Sports University, Cologne (L-11-10011-175-122000).
Disclosures: Dr. Helmich has nothing to disclose. Dr. Hedda has nothing to disclose.

Concussion-like symptoms Induced by Heat and Dehydration in a Varsity College Soccer Player: A Case Report

Abraham Chileuitt, MD; Javier Cardenas, MD

Objective

Show light on confounding presentations of heat and environmental related illnesses & mild TBI symptomatology. Identify overlapping symptomatology of heat illness & mild TBI.

Background

Heat illnesses, mostly heat exhaustion, tends to go under reported and many times, due to the nature of the activity, may be confused with a concussion despite the individual not experiencing any identifiable concussive event. Heat related illnesses are caused when the body is unable to regulate the cooling of itself. Normal physiological mechanisms such as sweating may not be sufficient to respond to the severe increase and change in temperature. As a result, the body temperature will raise to dangerous levels and cause damage to vital organs, including the brain. Today, there is very limited literature available that compares the symptoms of concussion vs heat illnesses.

Design/Methods

Case obtained from a Barrow Neurological Institute Concussion and Brain Injury patient. Case will reported from available history and clinic follow up visit. Overlapping symptoms of heat and concussion will demostrated in table format. No HIPPA information will be disclosed.

Results

The Soccer player was prevented from play due to a "Concussion" according to the Athletic trainer. No identifiable event was reported. Patient did experience Migranious headaches that were triggered by dehydration and execisseve heat exposure.

Conclusions

There is a significant overlap in concussion and heat related symptoms. Family history of migraines is a predisposing factor for both concussion and heat illness. Heat illness is noticeable underreported and may be confused as a concussion in high impact /collision activities; which, provides a challenge in itself due to nature of sports and exercise. Education about heat illness is important. More research is require to determine how much these two process overlap in symptomatology, are confounded & misdiagnosed, and occur concomitantly.

Study Supported By: NA.
Disclosures: Dr. Chileuitt has nothing to disclose. Dr. Cardenas has nothing to disclose.

Highly Sensitive Single Molecular Array Immunoassay Measurement of t-Tau, NF-L, GFAP, and UCH-L1 Biomarkers in Acute Concussion/Mild Traumatic Brain Injury (mTBI) Patient Serum and Saliva Samples

Ahmed Chenna, PhD; Christos Petropoulos, PhD; John Winslow, PhD

Objective

To determine if t-Tau, NF-L, GFAP and UCH-L1 protein biomarkers are elevated in early time points of acute concussion/mild traumatic brain injury patient serum and saliva, relative to control samples.

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Background

t-Tau, NF-L, GFAP and UCH-L1 levels have been reported to increase in cerebral spinal fluid (CSF) and blood following head trauma within 24 hours or longer, and are candidate diagnostic and prognostic biomarkers of concussion and mild to moderate TBI. However, limited information exists on the relationship between these biomarkers at short time points post-injury, and detectability in saliva of mTBI patients.

Design/Methods

Biomarker analysis of serum from a total of 120 participants, derived from two independent sample groups consisting of 60 concussion/mTBI patients each, with blood collected within 1-4 hr and 8-16 hr post-injury, respectively, was compared with 30 healthy control sera. Saliva samples were collected after 8-16 hr post-injury from a n = 30 subset of the same patients. Quanterix Simoa 4-plex immunoassay was used for highly sensitive measurements of these biomarkers.

Results

Median levels of NF-L, GFAP and UCH-L1 were significantly higher in independent sets of patient serum samples (n = 60 each), both at early (1–4 hr) and later (8–16 hr) time points post-mTBI/concussion, relative to control samples (n = 30) (p < 0.0001, = 0.0001, <0.0001, respectively). Low levels of t-Tau are detected, but are significantly elevated post-concussion relative to controls (p = 0.0001). Significant correlations were observed between levels of t-Tau and UCH-L1, NF-L and GFAP, and t-Tau and GFAP in both post-injury time-point groups, and between NF-L and UCH-L1 levels in the 8-16 hr group. The four biomarkers were detected in saliva from concussion/mTBI patients (n = 30).

Conclusions

This study supports the utility of ultra-sensitive multiplex immunoassays to detect increases in CNS proteins at high sensitivity in serum and saliva within 1-4 and 8-16 hr of concussion/mTBI.

Study Supported By: Monogram Biosciences/Laboratory Corporation of America Inc.

Disclosures: Dr. Chenna has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Monogram Biosciences, Laboratory Corporation of America. Dr. Petropoulos has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Monogram Biosciences (Laboratory Corporation of America). Dr. Winslow has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Monogram Biosciences, Laboratory Corporation of America.

Data from an emerging UK sports concussion clinic; should athlete assessment be sports-specific?

Naomi Deakin, MB BChir MA; Peter Hutchinson

Objective

To provide an overview of the Cambridge Sports Concussion Clinic; to investigate trends in patients' neurocognition utilising assessment with the Immediate Post-concussion Assessment and Cognitive Test (ImPACT) as stratified by sport.

Background

Professional sporting litigation in the USA has brought to the fore the issue of sports concussion. Despite this, UK outpatient management remains in its infancy, with less than five centres offering specialised post-injury review. This poster presents data from the Cambridge Sports Concussion Clinic (CSCC), comparing ImPACT assessments across motorsport and rugby.

Design/Methods

The data is a retrospective analysis of a prospectively maintained database cohort, in which demographic, clinical and neurocognitive data are archived. The submission includes CSCC patients who attended Addenbrooke's Hospital, Cambridge for clinical review June 2017-March 2019, who were diagnosed with concussion and completed an ImPACT assessment.

Results

36 post-injury reviews were completed across 19 clinical encounters with patients aged 15yrs+. 47% of athletes were injured during motorsport (saloon car, rally, motocross and single seater racing), 47% in rugby and 5% during equestrian activity. The majority were professional (47%) or competed in collegiate (21%) or high school (21%) competition with 1–13 years at their current sporting level (mean4.2 +/−SD 4.2 years). Only 22% of 18 patients were concussion-naïve prior to their current injury, with a range of 0–4 physician-confirmed diagnoses (1.7 +/− 1.3). Comparison of motorsport drivers versus rugby athletes reveals trends towards lower scores in ImPACT memory composite values (verbal F 0.57, t −1.4, p 0.15; memory F 2.1, t −0.9, p 0.37) and improved reaction time (F 3.3, t 1.8, p 0.08) with significant differences in visual motor speed (F 0.90, t−4.1, p < 0.001).

Conclusions

Preliminary cross-sport analyses indicate that motorsport competitors have worse composite memory scores, better reaction times and significantly altered visual motor speed. These early data provide support for sports-specific approaches.

Study Supported By: NA.

Disclosures: Dr. Deakin; Travel and (where relevant) subsistence expenses for role as 2018 Sid Watkins Scholar, co-funded by the world governing body for motorsport, the Federation Internationale de l'Automobile (FIA), the FIA Foundation and the Global Institute for Motor Sport Safety. Activities included attending and/or presenting at the Research Working Group and a number of FIA Commission meetings (including Disability & Accessibility, Closed Road, Medical). Salary support for role as Study Coordinator for RESCUE-RACER (a concussion in motorsport study), funded by the world governing body for motorsport, the Federation Internationale de Automobile (FIA). Dr. Hutchinson has nothing to disclose.

Observational Cohort Confirms Optic Nerve Sheath Dilation Post Valsalva in those with Prior mTBI

Chlowe Super; Lauren East; Parth Agrawal; Mary Dement; Ian Heger; Robert Givson; Matthew Lyon

Objective

The aim of this study was to prospectively assess the effect of mTBI on optic nerve sheath (ONS) dilation post transient increase in ICP.

Background

Our cross-sectional study demonstrated that those with a history of mild traumatic brain injury (mTBI) at least one year following their injury have significant ONS dilation after Valsalva as measured by ultrasound compared to those without a history of mTBI. This showed that ONS dilation after Valsalva could be a potential non-invasive method of identifying individuals with a history of mTBI but needed prospective confirmation.

Design/Methods

Mixed martial arts competitors that did not have ONS dilation of more than 0.5 mm on Valsalva, a value set based on cross-sectional study results, were enrolled in this prospective observational cohort study. Baseline pre and post-Valsalva optic nerve sheath diameter (ONSD) measurements were obtained for screening purposes. Additional ONSD measurements were collected after 1, 6, and 12 months of enrollment. Participants were monitored for suspected mTBI via self-report and monthly calls. Within two weeks following a physician-confirmed mTBI, the participant was scanned.

Results

Twenty-one participants were enrolled and 16 (76.2%) were followed up with for one year. Three participants experienced a mTBI. Scans

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conducted within two weeks of the mTBI showed no significant ONS dilation post-Valsalva, which was most likely due to an elevated pre-Valsalva value compared to the participant's baseline and one-year pre-Valsalva ONSD. At the one-year testing, individuals in the mTBI group had a significantly larger post than pre-Valsalva ONSD and a significant ONS dilation post-Valsalva (n = 3, mean = 1.01mm) when compared those who did not experience a mTBI (n = 13, mean = −0.12mm; $p = 0.0032$).

Conclusions

This study confirms the cross-sectional study results that following a mTBI, the ONS dilates significantly following Valsalva. Further exploration is needed into exactly when this dilation is seen during a patient's recovery and why it seems delayed.

Study Supported By: Medical Scholars Program, Medical College of Georgia at Augusta University, Augusta, GA.
Disclosures: Dr. Super has nothing to disclose. Dr. East has nothing to disclose. Dr. Agrawal has nothing to disclose. Dr. Dement has nothing to disclose. Dr. Heger has nothing to disclose. Dr. Gibson has nothing to disclose. Dr. Lyon has nothing to disclose.

Prevalence of Concussion in Quidditch

Michael Pepper, MD; Jeff Wayland; Adam Elwood; Spencer Walser; Vi Tran; Jose Posas, MD

Objective

The aim of our study is to assess the rate of concussion occurring while engaging in nontraditional sports such as Quidditch, and the effects that injury during a novelty sport may have on concussion detection when compared to more traditional sports.

Background

Concussions, once dismissed as nonconsequential, are rapidly attracting notice for acute and long-term health effects. Rates of recovery with repeated trauma is known to decrease with each occurrence. In novelty sports, regulation of concussions and proper return-to-play(RTP) protocol are not routinely enforced, resulting in repetitive injury to the detriment of players.

Design/Methods

IRB approval was obtained prior to survey distribution to all players associated with Major League Quidditch (MLQ). Responses were recorded and analyzed.

Results

157 responses were received. 63% were male and 37% female with mean age 22.9. 146 (93%) respondents confirmed or denied quidditch-related head injury. 22 (15%) denied head injury and 124 (85%) indicated hitting their heads while participating in the sport. 19% of respondents indicated >10 head injuries. 67 (54%) reported suspected concussion with an additional 41 (33%) reporting formal diagnosis with at least one concussion. EMS reported 18 injuries at MLQ matches. 5 (27.8%) were preliminarily diagnosed with concussion. 3 had no further treatment, 1 RTP and 1 received basic care. 0 recieved formal neurologic evaluation. Players were also asked about head injuries sustained in non-quidditch activities for comparison. 43 (27%) reported having medically diagnosed concussions outside of quidditch. 53 (34%) reported at least one suspected concussion without formal diagnosis. 24 (15%) answered maybe.

Conclusions

Our data supports that concussion is a significant burden in novelty sports such as quidditch. It is vital to recognize that with the rise of nontraditional sports, the prevalence of concussions in younger nontraditional athletes may be underreported and that concussion specialists must be cognizant of both traditional and novelty sports when evaluating long term effects of head trauma.

Study Supported By: Ochsner Clinic Foundation IRB.
Disclosures: Dr. Pepper has nothing to disclose. Dr. Wayland has nothing to disclose. Dr. Elwood has nothing to disclose. Dr. Walser has nothing to disclose. Dr. Tran has nothing to disclose. Dr. Posas has nothing to disclose.

Effects of football practice on blink reflex parameters in Division I football athletes

Dena Garner, PhD

Objective

The objective was to access the effects of football practice sessions on blink reflex parameters using the Eyestat.

Background

Our laboratory has utilized a potential objective measure to identify concussions. This technology, called Eyestat, is a noninvasive diagnostic tool measuring changes in blink reflex parameters. Prior research cited significant differences in various blink reflex parameters between active play, concussion, and baseline; however, the number of subjects for the active play population was small (N = 10). Thus, the purpose of this study was to identify blink reflex parameters during football practice, providing outcomes potentially helpful with its use for a concussed population.

Design/Methods

Forty-seven Division I male football players between the ages of 18-22 were evaluated on multiple sessions during a 2 week period of football practices. During various points of the practice, subjects completed the blink test and had their heart rate assessed. During the blink test, subjects placed their face against the apparatus, which directed a puff of air to the corner of the subject's eye to stimulate the blink. Five puffs were administered in a random fashion over a 20 second period in which videography captured and recorded the blink.

Results

Results of the study found significant differences in latency ($p = 0.0000$), time under the threshold ($p = 0.0176$), oscillations ($p = 0.0217$) and excursion ($p = 0.0003$), but no significant differences in differential latency ($p = 0.0626$). Average heart rate was 125 BPM, with a minimum of 72 BPM and maximum of 172 BPM. The results of this study correlate with prior research in latency, time under the threshold and excursions and support the changes in blink reflex parameters after football practice.

Conclusions

Future studies need to assess if changes occur with individual physical activity or is it related only to the practice of this sport.

Study Supported By: The product was provided by Blinktbi for research purposes.
Disclosures: Dr. Garner; I have been assigned stock options for the company (Blinktbi) which bought the product and which I researched and tested.

Residual Deficits in Vestibular Function Exist Following Return to Sports Participation from Concussion

Carolina Quintana; Nicholas Heebner; John ABt; Matthew Hoch

Objective

Determine if collegiate athletes exhibit residual deficits in vestibular function at the time of unrestricted return to participation (RTP) following a sports-related concussion (SRC).

Background

It has been well documented that afferent vestibular pathways are disrupted after SRC. This includes both the vestibular-ocular and vestibulospinal reflexes which mediate dynamic vision and postural stability. However, few studies have determined if vestibular function is recovered in athletes at the time of RTP from SRC.

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Design/Methods

Twenty-six NCAA Division-I athletes (1.77 ± 0.14 m, 92.81 ± 31.30 kg, 10 females, 16 males) performed the Concussion Balance Test (COBALT), the Dynamic Visual Acuity Test (DVAT), and Gaze Stability Test (GST). Thirteen athletes were tested within 14 days of RTP following SRC. Thirteen athletes with no history of SRC were matched to the RTP group based on age, sex, and sport to serve as healthy controls (HC). Paired t-tests with corresponding effect sizes compared COBALT, DVAT, and GST scores between groups (SRC, HC). For all tests, the alpha level was set a priori at 0.10.

Results

Twenty-six NCAA Division-I athletes (1.77 ± 0.14 m, 92.81 ± 31.30 kg, 10 females, 16 males) performed the Concussion Balance Test (COBALT), the Dynamic Visual Acuity Test (DVAT), and Gaze Stability Test (GST). Thirteen athletes were tested within 14 days of RTP following SRC. Thirteen athletes with no history of SRC were matched to the RTP group based on age, sex, and sport to serve as healthy controls (HC). Paired t-tests with corresponding effect sizes compared COBALT, DVAT, and GST scores between groups (SRC, HC). For all tests, the alpha level was set a priori at 0.10.

Conclusions

Our preliminary findings suggest that collegiate athletes who return to participation from SRC may experience residual deficits in postural control and visual acuity with dynamic head movements that challenge the vestibular system. Therefore, objective measures of vestibular function may be beneficial to ensure postural control and visual acuity are restored at RTP following SRC.

Study Supported By: NA.
Disclosures: Dr. Quintana has nothing to disclose. Dr. Heebner has nothing to disclose. Dr. Abt has nothing to disclose. Dr. Hoch has nothing to disclose.

Neurodevelopmental Disorders and Risk of Concussion: Findings from the NCAA-DOD Concussion Consortium

Brett Gunn; Steven Broglio, PhD; Michael McCrea, PhD; R. Davis Moore, PhD

Objective

We sought to assess the odds and relative risk of concussion in athletes self-reporting a diagnosis of learning disability (LD), attention deficit/hyperactivity disorder (ADHD), and LD + ADHD, relative to controls.

Background

Evidence suggests neurodevelopmental disorders (NDs) may be associated with an increased incidence of concussion, however no study has cross-sectionally and longitudinally assessed the associations of ND subtypes with concussion.

Design/Methods

2014-2017 Data from the NCAA-DOD Grand Alliance: Concussion Assessment, Research, and Education (CARE) Consortium were used to evaluate the likelihood of concussion for athletes with LD (n = 429), ADHD (n = 1513), and LD + ADHD (n = 323), relative to controls (n = 31,130). Odds of concussion history prior to enrollment, and relative risk of incurring a concussion following enrollment were calculated for all groups.

Results

The odds of having a concussion history prior to enrollment for athletes with LD was 1.61 (95% CI 1.31,1.97), and relative risk of incurring a concussion following enrollment for athletes with LD was 1.22 (95% CI .88, 1.69). The odds of having a concussion history for athletes with ADHD was 1.92 (95% CI 1.72, 2.14), and relative risk of incurring a concussion for athletes with ADHD was 1.51 (95% CI 1.29, 1.77). The odds of having a concussion history for athletes with LD + ADHD was 1.85 (95% CI 1.47, 2.33) and relative risk of incurring a concussion for athletes with LD + ADHD was 2.62 (95% CI 2.05, 3.35).

Conclusions

These preliminary results suggest NDs are associated with increased odds and relative risk of incurring a concussion, and athletes with LD + ADHD appear to be most susceptible to concussion. The authors acknowledge that CARE does not capture adequate control for athletic exposures like most sport epidemiology studies. Additionally, these were univariate associations and did not account for sport in which athletes were enrolled. Individuals with NDs could have similar risk once exposure, and sport enrollment are controlled for.

Study Supported By: The NCAA-DOD Grand Alliance: Concussion Assessment, Research, and Education (CARE) Consortium.
Disclosures: Dr. Gunn has nothing to disclose. Dr. Broglio has nothing to disclose. Dr. McCrea has nothing to disclose. Dr. Moore has nothing to disclose.

The Influence of Psycho-Stimulant Medication on Concussion Recovery in Athletes with ADHD: Findings from the NCAA-DOD Concussion Consortium

Brett Gunn; Michael McCrea; Steven Broglio, PhD; R. Davis Moore, PhD

Objective

We sought to longitudinally evaluate concussion recovery in collegiate athletes with ADHD who were and were not taking psycho-stimulant medication.

Background

Psycho-stimulant medication is commonly prescribed to individuals with ADHD. Some have posited that psycho-stimulant medications may mitigate impairments following sport-related concussion. However, no studies longitudinally evaluated the influence of psycho-stimulant medications on concussion recovery in collegiate athletes.

Design/Methods

Data from the NCAA-DOD Grand Alliance: Concussion Assessment, Research, and Education (CARE) Consortium were used to evaluate athletes with ADHD who were not taking psycho-stimulant medications (Rx-ADHD; n = 20), athletes with ADHD who were taking psycho-stimulant medications (Rx+ADHD; n = 20), and controls (n = 80). Athletes with ADHD were double-matched to controls on biological sex, age, and body mass index. All athletes were assessed prior to their sporting season, 24-48 hours post-injury, and again upon unrestricted return-to-play (RTP). Cognition and clinical symptoms were evaluated using the ImPACT test.

Results

Athletes in the Rx-ADHD (10.4 ± 1.5 days) and Rx + ADHD (11.9 ± 1.7) groups exhibited prolonged symptom durations compared to controls (4.2 ± .8; p's ≤ 0.05). Repeated-measures analyses of covariance (baseline scores = covariate) group × time interactions for multiple variables (p's ≤ 0.05). Univariate analyses revealed that both groups with ADHD demonstrated poorer verbal memory, and greater total symptoms at 24–48 hours post-injury than controls (p's ≤ 0.01). Additionally, athletes in the Rx-ADHD group demonstrated poorer cognitive efficiency at 24–48 hours post-injury, and at RTP than controls (p's ≤ 0.05). Lastly, athletes in the Rx+ADHD group demonstrated slower visual motor speed at 24–48 hours post-injury, and at RTP than controls (p's ≤ 0.05).

Conclusions

T Our findings suggest that following concussion athletes with ADHD may experience longer recovery than controls, regardless of medicated status. Interestingly, athletes with ADHD who were taking medication did not appear to have different recovery time relative to un-medicated athletes with ADHD.

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Disclosures: Dr. Gunn has nothing to disclose. Dr. McCrea has nothing to disclose. Dr. Broglio has nothing to disclose. Dr. Moore has nothing to disclose.

Flying may not affect symptom recovery after concussion in Athletes

Tara Sharma, OD; Julia Kerrigan, MD; David McArthur; Thomas McAllister, MD; Michael McCrea, PhD; Steven Broglio, PhD; Christopher Giza, MD, FAAN

Objective
To determine if there is a relationship between concussion recovery and airplane travel soon after injury in collegiate athletes and military cadets.

Background
Concussions are a common occurrence in young athletes. Very few studies have examined how flying may influence the clinical progression of a concussive injury.

Design/Methods
This is a prospective cohort study comprised of 3480 college athletes and cadets with concussion obtained from the Concussion Assessment, Research and Education (CARE) Consortium and divided in two groups: those who flew and those who did not fly after concussion. Those with unknown flight status were excluded. Demographics between groups were compared using Chi Square analysis. Symptom burden was calculated by subtracting baseline Sports Concussion Assessment Tool (SCAT3) symptom scores from the post-injury score after flying. Significance between outcome measures and flight status were evaluated using a paired t-test. Analysis of Variance (ANOVA) was used to determine if number of time zones crossed during flight influenced outcomes.

Results
165 athletes flew 31.8 ± 52.3 [SD] hours after injury, 2235 athletes did not fly, and 1080 had unknown flight status. There were no significant study group differences for age, sex, sport, history of prior concussion, and history of headache. No significant group differences were found in days to return to unrestricted play (p = 0.11), days after injury to start graded exertion (p = 0.50), duration of concussion symptoms (p = 0.23), days until return to normal academic performance (p = 0.75), and symptom burden (p = 0.47). Number of time zones crossed did not affect any outcomes.

Conclusions
Airplane travel early after concussion did not significantly affect recovery or severity of concussion symptoms in college athletes and cadets. Further studies need to investigate the possible effects of flying more acutely after injury. These data may help guide future recommendations on flight travel after concussion in athletes.

Study Supported By: NCAA-Dept of Defense CARE Consortium, UCLA Brain Injury Research Center, UCLA Steve Tisch BrainSPORT Program; UCLA Easton Brain Health Program, Stan and Patti Silver.
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Identifying the Gap: Factors Associated with Self-Reported Completion of Concussion Education in High School Athletes and Their Parent/ Guardian

Denise Mohrbacher; Anneliese Gall; Rebecca Harrison; Payton Wesley; Traci Snedden

Objective
This study aims to evaluate the completion of concussion education in a sample of Wisconsin high school student athletes and their parents/ guardians and identify factors associated with completion.

Background
Sport-related concussion is a significant public health concern. All 50 states have legislation mandating safety and prevention efforts aimed at reducing the burden of injury amongst the high school athlete population. Efforts include mandated concussion education for both athletes and their parents/ guardians. Previous studies have found that education leads to improved recognition of symptoms and improved outcomes. However, completion has not been formally assessed and factors that are associated with the completion are unknown.

Design/Methods
Secondary analysis of cross-sectional survey data collected during fall of 2017. Data for pre-identified demographic factors (eg. race, ethnicity, student grade level, highest education, income level) were extracted and summarized using descriptive statistics. Only participants who provided responses to variables of interest were included in this analysis (n = 224 dyads of student athlete and their parent/ guardian). Chi Square test of significance assessed associations between factors and completion of concussion education. Analyses performed using SAS version 9.4.

Results
The majority of student athletes self-identified as male (n = 123; 55.2%), white (n = 185; 87.7%) and non-hispanic (n = 192; 93.2%). Student athletes, who were older, in higher grade levels, had a history of concussion, and had parents/legal guardians with higher levels of education reported completing concussion education at higher proportions. Parents/ guardians reported completion of concussion education at higher proportions if they had a higher stated family income, their student athlete was in a higher grade level, and if their student athlete had a history of concussion.

Conclusions
A number of factors are associated with higher self-reported completion of mandated concussion education, identifying a gap. Further investigation is necessary to ensure all student athletes and their parent/ guardian are educated about concussion.

Study Supported By: This project was supported by the Clinical and Translational Science Award (CTSA) program, through the NIH National Center for Advancing Translational Sciences (NCATS), grant UL1TR002373, and the UW SMPH Wisconsin Partnership Program (WPP) grant #3086. The content is solely the responsibility of the authors and does not represent the official views of the NIH or WPP.
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Factors Influencing Coaches' Decisions about Concussion on the Sidelines of Youth Sports

Ann Guernon; Christina Papdimitriou

Objective
Identify coach reported factors influencing decisions about potential concussion in youth sports.

Background
Youth concussion in sport is an established public health concern. Coaches are the primary stakeholders deciding about removal from play for suspected concussion on the sidelines of competition and practice in most youth sports organizations. Estimates indicate over 2 million adults coach

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youth sports. Legislation across the U.S. and guidance from the Centers for Disease Control and the Concussion in Sport Group recommend players with suspected concussion be removed from play and not return prior to medical clearance and a graduated return to play protocol be followed.

Design/Methods

Qualitative semi-structured 1:1 interviews with coaches of youth community or school sponsored athletic programs in Illinois. Interview data was analyzed according to a constructivist grounded theory methodology employing constant comparative methods with an inductive approach to theme emergence.

Results

Sixteen coaches of recreational, competitive and scholastic athletic teams participated. Coaches were primarily white (94%) males (81%) with an average age of 47. Ten were volunteer coaches. Analytic themes related to decision making include: 1) personal experience drives decisions more than concussion training, 2) coaches fear the legal liability of missing a concussive event on the field, and 3) discomfort with the ambiguity of making decisions on the field. Coach perceived factors for improving comfort with decision making were: 1) availability of checklists or tools for use on the sidelines, 2) improve shared decision making with all stakeholders, and 3) access to medical professionals on the sidelines.

Conclusions

There is a possible misalignment between coaches' actual practices on the field and best practice guidelines. Coaches report behaviors on the sidelines that are distinct from practice guidelines and public health initiatives related to removal from play and return to play when events on the field present the potential for concussion.

Study Supported By: This is unfunded dissertation research by the first author of the abstract.
Disclosures: Dr. Guernon has nothing to disclose. Dr. Papdimitriou has nothing to disclose.

Comparison of Symptomology, Symptom Resolution Time, and Return to Play Time between Concussions Sustained in the Same Academic Year

Erin Wasserman; Sara Quetant; Melissa Baker; Sarah Morris; Christy Collins

Objective

The purpose of this study is to examine symptomology, symptom resolution time, and return to play (RTP) time between concussions sustained in the same academic year.

Background

Previous research shows that among those with a history of previous concussions, outcomes for a recurrent concussion are worse, especially when concussions occur within two weeks of each other. Despite this research, there has been little investigation into concussions that occur in the same academic year.

Design/Methods

Concussion data was collected from the National Collegiate Athletic Association (NCAA) Injury Surveillance Program (ISP) during the 2009/10-2017/18 academic years. Concussions were reported by athletic trainers (ATs) and were included if the student-athlete sustained two concussions in the same academic year. Proportions and means of symptoms, symptom resolution time, and RTP time were calculated, and, as appropriate, McNemar's tests and Wilcoxon sign-rank tests were used to compare these between the first and second concussions.

Results

Overall, 138 student-athletes sustained 276 concussions across 15 different sports a mean of 43 days apart (SD: 37.3). Fewer symptoms were reported in the second concussion compared to the first (4.3 vs. 5.2, respectively; $p = 0.01$). RTP time was, on average, five days longer for the second concussion ($p = 0.01$), and a larger proportion of second concussions resulted in participation restriction of ≥30 days (first: 7.3%, second: 26.8%; $p < 0.01$). Symptom resolution time did not differ between the first and second concussions.

Conclusions

Although the RTP time was greater in second concussions compared to first, symptom resolution time did not differ. This suggests that there may be a difference in AT management of second concussions, with a more conservative, extended RTP progression. Further research is needed to examine the association between time between concussions and differences in concussion presentation.

Study Supported By: Funding for this study was provided by the NCAA. The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of the program's sponsor.
Disclosures: Dr. Wasserman has nothing to disclose. Dr. Quetant has nothing to disclose. Dr. Baker has nothing to disclose. Dr. Morris has nothing to disclose. Dr. Collins has nothing to disclose.

CONCUSSION REPORTING IN YOUTH SPORTS: A GROUNDED THEORY APPROACH

Penny Morgan Overgaard

Objective

The purpose of this study was to generate a grounded theory that explained concussion reporting in youth sports from the perspective of the young athletes.

Background

Participation in youth sports is increasingly popular with estimates of 35 – 40 million U.S. children playing an organized sport each year. Current concussion education has not been shown to be consistently effective. The risk of concussion exposure is present in a number of youth sports. Much of the research surrounding concussion reporting has targeted older adolescents. A better understanding of the reporting process among younger athletes is needed.

Design/Methods

A grounded theory approach was used to gather and analyze data from semi-structured interviews with soccer players ages 5 to 12. The sample consisted of eleven athletes (8 male, 3 female) from non-elite soccer leagues in two counties; Maricopa, Arizona and Santa Barbara, California.

Results

Data analysis induced four conceptual categories; trusted environment, self-monitoring, being a player and incentive structure. The resultant theoretical model explains injury reporting from the perspective of young athletes. This study suggests that there is an incentive structure related to injury reporting, that young athletes have a good understanding of the incentives in relation to their perception of self as a player. Athletes demonstrate self-agency in terms of self-monitoring, however important adult others provide a trusted environment that makes children feel safe with their decisions.

Conclusions

This study suggests that a better understanding of the incentive structure embedded in the reporting process is needed to design effective prevention and education strategies. Important other adults such as parents and coaches may play a pivotal role in injury reporting among younger athletes when compared to adolescents.

Study Supported By: This was an unsponsored study that was part of a dissertation.
Disclosures: Dr. Overgaard has nothing to disclose.

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Non-physiological Speech Disturbance in Teen Athletes with Concussion: A Case Series

Tanya Shah; Kate Essad, MD

Objective

This report is intended to share unique patient cases featuring a common but inadequately researched problem in adolescents with concussion.

Background

Despite evidence associating concussion with increased risk of mental illness, the literature has limited information examining functional speech disorder as a sequala of concussion in teen athletes [Table 1].

Design/Methods

A PubMed search was completed using the following key words: functional speech disorder, conversion disorder, concussion, pediatrics. A total of five articles resulted and were reviewed.

Results

A 14yo female with a concussion from volleyball had a protracted course of recovery due to anxiety. Months later, she was struck by a tennis ball without a second concussion. She developed a non-physiologic stutter and atasia-abasia. She recovered with cognitive behavioral therapy (CBT). A 16yo female with history of depression sustained a concussion playing soccer with an associated slurred speech. Two weeks later, her initial concussion symptoms resolved however she began stuttering. She was treated by adjusting her psychiatric medications. Two years later she sustained another concussion which caused a reoccurrence of stuttering. Symptoms improved after a partial day program with psychiatry and intensive speech therapy. An 18yo male wrestler with no psychiatric history suffered a concussion. He developed catatonia with echolalia. He was unable to participate in CBT, however symptoms have partially improved with diazepam.

Conclusions

This series highlights pediatric athletes presenting with functional speech disorders after concussion or an event triggering anxiety of concussion. The development of conversion disorder of speech was independent of any pre-disposing psychiatric history. Psychological treatment with CBT or medication successfully improved conditions in all cases. Providers should counsel patients and families of potential stress-response symptoms that can occur with concussion. Ongoing research is needed to establish patterns of these conditions and provide evidenced based guidelines to best direct treatment of these young athletes.

Study Supported By: NA.
Disclosures: Dr. Shah has nothing to disclose. Dr. Essad has nothing to disclose.

Relationship between serum-based biomarkers & Magnetic Resonance Imaging measures following mild traumatic brain injury in collegiate athletes post return to play

Taylor Susa; Marguerite Moore, PhD, ATC; Joshua Carlson

Objective

This study analyzed MRI and serum samples from 30 participants across two groups to explore the relationship between protein levels and MRI scans in post return-to-play collegiate athletes following concussion.

Background

Recently, there has been an increase in concussion research on their effects on different protein levels in serum (a derived portion of blood) between concussed and control groups. Recent research examining serum biomarkers in concussion have found elevated levels of many proteins, but overall have mixed results in correlation with MRI. However, these studies have not focused on the lingering effects that exist in post return-to-play.

Design/Methods

The first group (n = 15) consisted of recently cleared to return-to-play collegiate athletes after experiencing a sports-related concussion. The second group (n = 15) was collegiate athlete controls matched on age, sex, and sport. Serum samples were collected to assess the levels of proteins following post return-to-play. These proteins were evaluated using Enzyme-Linked Immunosorbent Assay kits (ELIASA).

Results

An overall BDNF effect was observed between groups ($p < 0.05$), the concussed group exhibited significantly higher levels of serum BDNF compared to the control group. A positive association between BDNF and gray matter volume (GMV) was observed at a 250 voxel cluster level in both the right ($p_{FDR} = 0.015$) and left cerebellum region ($p_{FDR} = 0.045$) across groups. A negative association between BDNF and GMV in both groups was observed in the brainstem ($p = 0.029$) and the precuneus ($p = 0.017$) areas. A differential relationship between group and BDNF on GMV was observed ($p = 0.022$) in the prefrontal cortex.

Conclusions

Previous research has not examined the post return-to-play effects in neuroplasticity specific proteins, nor the time frame of injury in comparison to controls with MRI. Serum-based biomarkers and MRI grant a better depiction of what is occurring during post return-to-play.

Study Supported By: Internal funding awarded to MTM, JMC, and TRS.
Disclosures: Dr. Susa has nothing to disclose. Dr. Moore has nothing to disclose. Dr. Carlson has nothing to disclose.

The Effect of Repetitive Head Impact in Sensory Reweighting in Collision College Athletes

Fernando Vanderlinde Santos; Jaclyn Caccese, PhD; Felipe Yamaguchi; John Jeka

Objective

To compare sensory reweighting for upright stance between collegiate collision and non-contact sport athletes.

Background

The potentially adverse effects of repetitive head impact (RHI) exposure through routine collision sport participation have become a major public health concerns.

Design/Methods

Thirty male collegiate athletes were grouped by sport type, including collision (n = 15, 21.2 ± 2 years, 85.9 ± 13.8 kg, 179.7 ± 8.2 cm) and non-contact (n = 15, 20.8 ± 2.1 years, 72.9 ± 4.8 kg, 178.3 ± 4.3 cm) sport athletes. Participants underwent a standing balance assessment; they experienced simultaneous perturbations to visual, vestibular, and somatosensory systems. The visual stimulus consisted of 500 pyramids displayed on a virtual reality cave and translated in the anterior-posterior direction at 0.2 Hz in a sinusoidal waveform. The vestibular stimulus consisted of binaural-monopolar galvanic vestibular stimulation (GVS) at 0.36 Hz in a sinusoidal waveform. The somatosensory stimulus consisted of bilateral Achilles' tendon vibration at 0.28 Hz in a square waveform with equal on/off times. Different frequencies were chosen for each modality so that we could calculate the gain to each stimulus independently. There were four conditions: two conditions of each high amplitude (0.2 m) and low amplitude (0.8 m) visual scene translation and two conditions of each vibration on and vibration off. The leg segment gain to each modality was compared between groups and across conditions using a repeated-measures ANOVA.

Results

There were no changes in leg segment gain to vision (i.e. group effect; $F = 2.624$, $p = 0.094$, $\eta^2 = 0.086$), gain to GVS ($F = 1.341$, $p = 0.266$, $\eta^2 =$

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0.46), or gain to vibration (F = 3.124, $p = 0.088$, $\eta^2 = 0.100$). In addition, there were no changes in sensory reweighting for any modality (i.e. condition X group effect; vision, F = 0.074, $p = 0.788$, $\eta^2 = 0.003$; GVS, F = 0.547, $p = 0.46$, $\eta^2 = 0.019$; vibration, F = 0.734, $p = 0.399$, $\eta^2 = 0.026$).

Conclusions

Our findings suggest that there are no differences in sensory reweighting between collegiate collision and non-contact sport athletes. Despite concerns that RHI exposure through routine collision sport participation may result in balance disturbances, our results do not support this association.

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Disclosures: Dr. Santos has nothing to disclose. Dr. Caccese has nothing to disclose. Dr. Yamaguchi has nothing to disclose. Dr. Jeka has nothing to disclose.

Regaining memory after a second hit and other misconceptions about concussion in college athletes and non-athletes

Ruta Clair, PsyD; Agnes Reed; Lisa Kelly; Julia Pisker

Objective

To understand misconceptions aout concussion in college athletes and non-athletes.

Background

Formal education in concussion appears to be limited to individuals who participate in organized sports at the NCAA level. Overall, there is limitedresearch comparing athletes and non-athletes.

Design/Methods

A minimally modified version of the ROCKAS-ST and modified demographics/symptom knowledge questions were administered to 312 college students during the 2018-19 academic year. Participants included college athletes, individuals who participated in high school sports, and individuals with no formal athletic experience.

Results

Current collegiate athletes demonstrated better knowledge than non-athletes, $F(2,308) = 3.17$, $p = .043$, but the difference was only 1 question out of 21 and the effect size was small. Misconceptions were evident across groups and included believing that a second injury allows the individual to remember information forgotten as a result of the first concussion (30.1%) and that a concussion can cause an individual to forget who they are and not recognize others but be healthy in every other way (63%). While 97% recognized headache as a symptom of concussion there were also misunderstandings such as 28% of participants identifying breathing problems as a central symptom of concussion. In identifying which demographic factors other than collegiate athletics were related to improved knowledge, individuals who experienced a concussion demonstrated better knowledge ($t(309) = -2.165$, $p = 0.04$) as did participants who received education from multiple sources ($F(1,309) = 4.712$, $p = .03$, $R^2 = 0.015$).

Conclusions

While collegiate athletes demonstrate better concussion knowledge than college students who have never been athletes, there continues to be much work to be done. Misconceptions abound and it appears that other than sustaining a concussion, having more sources of education may result in better knowledge.

Study Supported By: No funding sources were obtained. Research was approved by Cabrini University IRB.
Disclosures: Dr. Clair has nothing to disclose. Dr. Reed has nothing to disclose. Dr. Kelly has nothing to disclose. Dr. Pisker has nothing to disclose.

Resting State Functional Connectivity is Directly Related to Clinical Presentation of Mild Traumatic Brain Injury

Teena Shetty, MD; Joseph Nguyen; Esther Kim; George Skulikidis; Matthew Garvey; Caitlin Miller; Taylor Sogsil; Apostolos Tsiouris; Sumit Niogi; Aashka Dalal; Kristin Halvorsen; Tianhao Zhang; Joseph Masdeu, MD, PhD, FAAN; Pratik Mukherjee; Luca Marinelli

Objective

To determine the utility of fractional amplitude of low frequency fluctuations (fALFF) during resting state fMRI (rs-fMRI) as an advanced neuroimaging biomarker for Mild Traumatic Brain Injury (mTBI).

Background

mTBI is defined by a constellation of functional rather than structural deficits. As a measure of functional connectivity, fALFF has been implicated in long-term outcomes post-mTBI. It is unclear however, how longitudinal changes in fALFF may relate to the clinical presentation of mTBI.

Design/Methods

111 patients and 32 controls (15–50 years old) were enrolled acutely after mTBI and followed with up to 4 standardized serial assessments. Patients were enrolled at either Encounter 1 (E1), within 72 hours, or Encounter 2 (E2), 5–10 days post-injury, and returned for Encounter 3 (E3) at 15–29 days and Encounter 4 (E4) at 83–97 days. Each encounter included a clinical exam, neuropsychological assessment, as well as rs-fMRI imaging. fALFF was analyzed independently in 14 functional networks and, in grey and white matter as a function of symptom severity. Symptom severity scores (SSS) ranged from 0–132 as defined by the SCAT2 symptom evaluation.

Results

In mTBI patients, fALFF scores across 5 functional brain networks (language, sensorimotor, visuospatial, higher-order visual, and posterior salience) differed between mTBI patients with low versus high SSS (SSS <5 and >30, respectively). Overall, greater SSS were indexed by reduced connectivity ($p < 0.03$, Bonferroni corrected). Further analysis also identified corresponding network pairs which were most predictive of increased SSS. White matter fALFF was not correlated with symptom severity, however, decreased grey matter fALFF was significantly correlated with greater SSS ($r = -0.25$, $p = 0.002$).

Conclusions

Grey matter fALFF was correlated with mTBI symptom burden suggesting that patterns of neural connectivity relate directly to the clinical presentation of mTBI. Furthermore, differences in functional network connectivity as a function of SSS may reflect which networks are implicated in recovery of mTBI.

Study Supported By: GE-NFL.
Disclosures: Dr. Shetty has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with GE/NFL Medical Advisory Board. Dr. Shetty has received research support from General Electric, National Football League, Chembio/Perseus, ElMindA and Teva Pharmaceuticals. Dr. Nguyen has nothing to disclose. Dr. Kim has nothing to disclose. Dr. Skulikidis has nothing to disclose. Dr. Garvey has nothing to disclose. Dr. Miller has nothing to disclose. Dr. Cogsil has nothing to disclose. Dr. Tsiouris has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with Parexel, BioClinica, and ICON. Dr. Niogi has nothing to disclose. Dr. Dalal has nothing to disclose. Dr. Halvorsen has nothing to disclose. Dr. Zhang has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with General Electric. Dr. Masdeu has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with GE/NFL Medical Advisory Board. Dr. Masdeu has received research support from General Electric, National Football League. Dr. Mukherjee has received personal compensation for consulting, serving on a scientific advisory board, speaking, or other activities with GE/NFL Medical Advisory Board. Dr.

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Development and Assessment of a Novel Peer Concussion Education Program for College Athletes

Meredith Kneavel; William Ernst; Kevin McCarthy

Objective

To evaluate the effectiveness of a novel peer concussion education program designed to increase knowledge of concussions, reporting of concussive events, and attitudes for both teammates and individuals in high concussive sports.

Background

Over 460,000 student-athletes compete in 24 NCAA sports every year. Concussions are estimated to occur between 0.43—0.57 per 1000 athletic events for student-athletes (Covassin, et al., 2016; Daneshvar et al., 2011) but these rates rely in part on self-report, which is likely affected by factors including the culture surrounding athletics (IOM, 2013). The Institute of Medicine, NCAA, Department of Defense, and the CDC have all called for educational interventions to change the culture of competitive athletics pertaining to concussion so that reporting of concussion becomes the norm.

Design/Methods

A multi-site randomized controlled trial was conducted to evaluate the effectiveness of the program. Measures of concussion knowledge, knowledge of the return to play protocol, intention to report concussions, direct subjective norms, direct perceived behavioral control, and indirect perceived behavioral control were assessed at baseline, post-intervention, and at a one-month follow-up with the last four measuring perspectives for both self and teammate.

Results

1614 male and female student-athletes from 60 teams (30 experimental, 30 control) belonging to 10 colleges/universities across all 3 NCAA Divisions completed the study. Results indicated that student-athletes who participated in the program demonstrated greater increases in concussion knowledge, intention to report concussion, understanding of the return to play protocol, direct subjective norms, direct perceived behavioral control, and indirect perceived behavioral control for both self and teammate compared to controls post-intervention and at the one-month follow-up.

Conclusions

The novel peer-mediated approach to concussion education shows promise in increasing concussion knowledge, intention to report concussion, and for facilitating attitudinal changes that support reporting among student-athletes and in changing the norms of concussion reporting on a team.

Study Supported By: This research was made possible, in part, with support from the National Collegiate Athletic Association - U.S. Department of Defense Mind Matters Challenge.
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ImPACT in UK motorsport; is this the right concussion assessment for our drivers?

Naomi Deakin, MB BChir MA; Paul Trafford

Objective

To investigate the proportion of learning difficulties in UK motorsport competitors and the effect on ImPACT scores at baseline.

Background

Motorsport competitors have a higher risk of concussion compared to other high-risk sports participants (Deakin et al.). The current worldwide gold standard for management in motorsport is the completion of baseline and post-injury ImPACT, however there has been no formal validation for this population.

Design/Methods

This is a retrospective analysis of a prospectively-maintained database cohort, in which demographic and neurocognitive data are archived. The submission includes TOCA competitors aged 14 years and above who completed baseline ImPACT assessments between June 2016-October 2018.

Results

229 drivers completed baseline ImPACT across three racing seasons in six UK-based championships. Drivers had 0–25 yrs experience at their current level (1.69 +/− 3.0) and the majority were semi-professional (52.4%). 97% of drivers were male and 89% were right-handed. Drivers had completed 8–20+ years of education (12.17 +/− 2.35) at the time of assessment. Almost a fifth had a formal diagnosis of dyslexia (16.6%). When comparing non-diagnosed to dyslexic drivers there was significantly poorer performance on verbal, visual and visual motor composite scores (t3.2, $p < 0.05$; t3.6, $p < 0.001$; t4.3, $p < 0.001$; respectively) and non-significant effect on reaction time (t1.4, $p > 0.05$).

Conclusions

This motorsport cohort exhibits a higher prevalence of dyslexia than the general population (16.6% vs. 10%), with dyslexic drivers performing significantly worse at baseline on most composite scores. Future post-injury analyses will indicate whether ImPACT is sensitive to the diagnosis of concussion in this unique sporting group.

Study Supported By: NA.
Disclosures: Dr. Deakin; Travel and (where relevant) subsistence expenses for role as 2018 Sid Watkins Scholar, co-funded by the world governing body for motorsport, the Federation Internationale de l'Automobile (FIA), the FIA Foundation and the Global Institute for Motor Sport Safety. Activities included attending and/or presenting at the Research Working Group and a number of FIA Commission meetings (including Disability & Accessibility, Closed Road, Medical). Salary support for role as Study Coordinator for RESCUE-RACER (a concussion in motorsport study), funded by the world governing body for motorsport, the Federation Internationale de Automobile (FIA). Paul Trafford has nothing to disclose.

Does the Concussion Clinican Examination Predict Post-Concussion Subsequent Musculoskeletal Injury?

Thomas Buckley, PhD; Jessie Oldham; Nancy Getchell; Buz Swanik; Rob Lynall; Caroline Howard

Objective

To identify post-concussion subsequent lower extermity musculoskeletal injury predictors from a clinical concussion assessment.

Background

Emerging evidence has identified an elevated risk of subsequent lower extremity musculoskeletal injury (LE-MSK) in the year post-concussion. This approximately 2-fold elevated risk has been identified in diverse populations including high school, college, professional sports and military populations. While persistent impairments in postural control are a speculated mechanism, these assessments require instrumented biomechanical measures; thus, there are currently no clinically feasible predictors which have been identified.

Design/Methods

Eighty three NCAA Division I student-athletes (51.8% female, ht: 1.75 +/− 0.12 m, wt: 76.2 +/− 20.1 kg) who had suffered a sports related concussion (LOC: 7.5%, PTA: 12.2%) with baseline data were assessed

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within 72 hours post-concussion were included in this retrospectic study. The clinical examination consisted of the Balance Error Scoring System (BESS), Standard Assessment of Concussion (SAC), Clinical Reaction Time (CRT), King-Devick (KD) and the Immediate Post-Concussion Assessment and Cognitve Test (ImPACT) composite values. Change scores (Δ) from baseline to acute post-concussion served as predictors to identify subsequent LE-MSK with a step wise binary logistic regression.

Results

The subsequent LE-MSK rate was 72.3% (60/83). The overall model failed to identify a predictive relationship between change scores and subsequent injury risk ($r^2 = 0.242$, $p = 0.458$). Exploratory testing failed to identify any significant individual predictors of subsequent LE-MSK: BESS: Δ = −0.35 errs, $p = 0.964$; SAC: Δ = −0.55, $p = 0.239$; ImPACT Verbal Memory: Δ = −0.53, $p = 0.324$; ImPACT Visual Memory: Δ = −5.6, $p = 0.750$; ImPACT Motor Speed: Δ = −2.81, $p = 0.070$; ImPACT Reaction Time: Δ = 0.042 sec, $p = 0.164$; CRT: Δ = 12.2 ms, $p = 0.564$; and KD: Δ = 2.8 sec, $p = 0.607$.

Conclusions

None of the common clinical concussion assessments were a significant predictor of subsequent LE-MSK potentially due to a high injury rate (72.3%). Future research should continue attempts to idenify clinically feasible predictors to allow clinicians to identify at-risk athletes to engage injury prevention strategies to reduce subsequent LE-MSK.

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Disclosures: Dr. Buckley has nothing to disclose. Dr. Oldham has nothing to disclose. Dr. Getchell has nothing to disclose. Dr. Swanik has nothing to disclose. Dr. Lynall has nothing to disclose. Dr. Howard has nothing to disclose.

Females have a Higher Post-Concussion Subsequent Injury Rate than Male Collegiate Athletes

Thomas Buckely, PhD; Jessie Oldham

Objective

The purpose of this study is to compare post-concussion lower extremity musculoskeletal (MSK) injury between sexes.

Background

Emerging evidence suggests that there is an elevated risk of lower extremity MSK injury in the year following concussion. Indeed, we have previously reported a 1.6 –2.9 times elevated risk of lower extremity injury across a diverse population of collegiate student athletes at the conclusion of their athletic careers. However, there are recent and important calls to investigate the role of gender in concussion research and collegiate female student-athletes have elevated risks of specific injuries.

Design/Methods

We recruited 335 student-athletes (62.1% female, mean age, 21.2 ± 1.4 years old) across 13 sports from 17 NCAA member institutions. Participants self-reported concussions under three categories: 1) selfreported concussions, 2) acknowledged unreported concussions (e.g., "hidden"), 3) unrecognized concussions (e.g., memory loss following a head impact). The lower extremity MSK injuries were self-reported 1) lateral ankle sprains, 2) knee sprains, or 3) lower extremity muscle strain. Chi-square analyses identified the association between each of the concussion variables and lower extremity MSK between self-reported sexes.

Results

For females, there was a significant association between 1) reported concussions and knee injuries ($p = 0.018$, OR = 2.22, 95% CI: 1.18 – 4.21), 2) unreported concussions and knee injuries ($p = 0.005$, OR = 3.73, 95% CI: 1.51 – 9.22), 3) unrecognized concussions and lateral ankle sprains ($p = 0.007$, OR = 2.61, 95% CI: 1.32 – 5.15). For males, there was only a significant association between unrecognized concussions and muscle strains ($p = 0.020$, odds ratio = 2.39, 95% CI: 1.16 – 4.92).

Conclusions

The results of this study suggest females are at higher risk of post-concussion subsequent MSK injury over the course of their collegiate athletic career. Consistent with recent concussion related findings, these results may highlight a gender difference in concussion response and suggests future studies continue to differentiate gender during analysis.

Study Supported By: NA.
Disclosures: Dr. Buckley has nothing to disclose. Dr. Oldham has nothing to disclose.

Association of physiological variables with subconcussive head impacts in high school American football

Megan E. Huibregtse; Steven W. Zonner; Keisuke Ejima; Zachary W. Bevilacqua; Sharlene D. Newman; Jonathan T. Macy; Keisuke Kawata

Objective

The purpose of this investigation was to examine the relationships between subconcussive head impact frequency and magnitude and measures of physical exertion and muscle damage.

Background

Subconcussive head impacts, or impacts that do not present with concussion symptoms, are gaining traction as a major public health concern. However, there is a gap in knowledge about the contribution of physiological variables, such as muscle damage and physical exertion, to neurological measures used to assess subconcussive impact-dependent changes. The unknown contribution of physical exertion and strenuous exercise is often listed as a limitation in field studies of subconcussive head impacts.

Design/Methods

Fifteen high school football players wore mouthguards installed with triaxial accelerometers and gyroscopes in order to quantify the linear and rotational accelerations of every head impact sustained throughout one season (practices and games). Additionally, serum samples were collected at twelve time points (pre-season, pre- and post-competition for five in-season games, and post-season) and assayed for CK-MM, the skeletal muscle-specific isoenzyme of creatine kinase. Subjects wore heart rate monitors during the five games, and heart rate data were used to estimate physical exertion in terms of excess post-exercise oxygen consumption (EPOC).

Results

Mixed-effect regression modeling (MRM) showed significant and positive associations between CK-MM and subconcussive head impact kinematic variables, in addition to a significant and positive association between CK-MM and EPOC. The models were adjusted for cumulative head impact exposures up to each game and the pre-season serum CK-MM levels, when applicable.

Conclusions

When investigating subconcussive head impacts, the effects of muscle damage should be considered when using correlated outcome measures, such as inflammatory biomarkers and vestibular assessments.

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Symptom Provocation Patterns During Supervised Exercise in Adolescent Athletes with Concussion

Michael Popovich, MD; Andrea Almeida, MD; Andrew Sas, MD, PhD; Jeremiah Freeman; Bara Alsalaheen; Matthew Lorincz, MD, PhD; James Eckner, MD

Objective

To understand which exercises provoke symptoms, as well as the type and frequency of symptoms, during supervised exercise (SE) following concussion, and to better understand how to interpret and utilize findings during SE.

Background

Exercise is increasingly used in the management of sport-related concussion, and SE has been shown to be associated with faster clearance to return to sport. However, the optimal use of exercise following concussion is not known, and findings during SE have not been studied.

Design/Methods

This study is a retrospective review of patients seen at a sport concussion clinic. Participants were concussed athletes under age 18 who underwent SE within 30 days of concussion. A typical SE session began with a basic cardiovascular exercise followed by dynamic exercise challenges. Data recorded included exercise type, pre-exercise symptoms, symptom exacerbation scores, and maximum heart rate during exercise. A symptom was considered provoked if a new symptom developed or if an existing symptom increased by ≥3 points on a 10 point scale. Outcome measures were referral to vestibular physical therapy and the number of days from concussion until clearance for return to sport. Data were analyzed using two-sample t tests, linear and logistic regression models.

Results

66.2% of patients experienced symptom provocation during SE. Symptom provocation did not occur until the dynamic challenge portion of the workout in 55.6% of those symptomatic. Dizziness was the most common symptom (48.5%), and medicine ball exercises (50.0%) the most common provoking exercise. Dizziness provoked during SE predicted referral to vestibular physical therapy (OR 5.90, $p = 0.015$). Provocation of symptoms during basic cardiovascular exercises predicted a greater number of days until clearance for return to sport ($p = 0.015$).

Conclusions

Symptom provocation during SE provides useful information in return to play decision making, guidance for physical thearpy treatments, and prognostication of recovery time following concussion.

Study Supported By: NA.

Disclosures: Dr. Popovich has nothing to disclose. Dr. Almeida has nothing to disclose. Dr. Sas has nothing to disclose. Dr. Freeman has nothing to disclose. Dr. Alsalaheen has nothing to disclose. Dr. Lorincz has nothing to disclose. Dr. Eckner has nothing to disclose.

Reduced cognitive resiliency ofattention-deficit/hyperactivity disorder against subconcussive head impacts

Madeleine Nowak; Patrick Quinn; Keisuke Ejima; Timothy Mickelborough; Sharlene Newman; Keisuke Kawata

Objective

The purpose of this study was to determine the subconcussive head impacts (SHI) effects on neurocognitive function in individuals diagnosed with attention-deficit/hyperactivity disorder (ADHD).

Background

Athletes diagnosed with ADHD have a heightened risk (2 to 4-fold) for sustaining concussion. However, their response to repetitive SHI remain unclear.

Design/Methods

In this case-control intervention study, 17 soccer players clinically diagnosed with ADHD who take their prescribed medication daily, were assigned a heading intervention (ADHD-Heading group),individuals who met the ADHD criteria but were non-soccer players, were assigned into a kicking group, (ADHD-Kicking group, n = 15). Whereas 34 soccer players without ADHD diagnosis were randomized into either a heading or kicking intervention, yielding Non-ADHD-Heading group (n = 17) or Non-ADHD-Kicking group (n = 17). To implement SHI, the heading groups executed 10 headers with a standard soccer ball projected at a velocity of 25 mph (equivalent to a long throw-in) over 10 minutes by a JUGS soccer machine, while the kicking groups performed 10 kicks. Neurocognitive function was measured via the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) at pre-intervention baseline, 0h, 2h, and 24h post-intervention.

Results

The vulnerability to SHI was notable in subjects diagnosed with ADHD particularly in memory, as illustrated by a significant group × time interaction, $F(6,96) = 3.796$, $p = 0.002$. Both Kicking groups improved verbal memory over time indicating the brain's ability to learn, whereas the Non-ADHD-Heading group showed no improvement. The ADHD-Heading group showed a significant decline at 0h and 2h post-heading compared to other groups. As for visual memory, the ADHD-Heading group showed a significant decline at 24h post; however, all other groups displayed improvement. There were no group differences in remaining domains.

Conclusions

Data suggests neurocognitive vulnerability in athletes diagnosed with ADHD after experiencing SHI, specifically in memory performance. These outcomes can better inform clinicians; overall, promoting a better personalized care in athletes diagnosed with ADHD.

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Novel Pre-Season Concussion Baseline Assessment Including Protocols based on Recognizable Clinically-Relevant Neurosensory Methodologies

Jonathan Vincent; Joseph Clark; Robert Mangine; Kimberly Hasselfeld; Aaron Keuhn-Himmler; Jon Divine; Angelo Colosimo; Enna Selmanovic; Nicole Giordano; Bradley Jacobs

Objective

Our goal was to develop and validate a neurophysiological-centric baseline model that can be appreciated by the broader neuro community and practically utilized by the sports community.

Background

As concussions, a mild traumatic brain injury, and other traumatic brain injuries gain notoriety amongst public awareness, there has been a rise in available computer-based concussion baseline assessments. Furthermore, states, sporting agencies, and schools are mandating implementation of concussion baselines. However, validation and standardization of these current baseline neurological tests have been remiss and are often not utilized by medical or neurological practitioners, making their utility suspect.

Design/Methods

We applied our neurocognitive baseline program to college football freshmen and high school aged ice hockey players. The list of baseline

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assessments is: eye-hand coordination reaction time using the Dynavision D2™ device, stereopsis measurements, phoria, oculomotor performance, electroretinography and visual-evoked potential, binocularity, optical coherence tomography, peripheral vision assessments, and balance.

Results

The results suggest that this baseline program can be performed as a battery appropriate for a pre-participation examination prior to sport participation. The data derived from said baseline can be interpreted by sport, age and gender specific. These demographics can also be examined for developing normative data and useful for identifying subjects outside this normal.

Conclusions

It is felt that the current state of concussion baselines for athletic organizations are inadequate. We chose to identify a series of baseline tests that are more clinically-relevant and easy to perform as evidenced from the preseason baseline used by the University of Cincinnati athletes and non-collegiate athletes. These baselines are used as part of the standard pre-participation examination, further providing valuable insight into the development of sports vision training performance enhancement programs and extensively relied upon as a pre-season concussion baseline. We feel this model has enhanced clinical utility compared to the current wide spread computer-based neuropsychological assessments.

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Academic concerns, requested and received support among adolescents in the four weeks following a concussion injury: A pilot study

Traci Snedden; Eric Post; Christian Schmidt; M. Alison Brooks

Objective

To describe the scope of academic concerns, requested and received support among adolescents in the four weeks following a concussion injury.

Background

Recent studies have found alterations in cognitive ability after concussion that cause learning issues upon return to the classroom. Findings have prompted guidelines for supporting return to learn post-concussion in recent statements from the CDC and the AAP. However, a gap exists specific to academic concerns and needs across the recovery timeline.

Design/Methods

Prospective longitudinal pilot study. Adolescents, 13-18 years, were enrolled within 7 days of diagnosed concussion injury. Academic effects, requested and received support were assessed by e-survey at 4 time points across 28 days, each one week apart.

Results

Overall, 37 adolescents (51.4% female, mean age: 16.4 ± 1.4 years) provided sufficient data for analysis. A decrease in the frequency of academic concerns over time was noted across the 4 weeks following injury with 37.8% (n = 14) reporting challenges in one or more of their classes in the first week after their concussion, compared to 10.8% (n = 4) at 28 days. A decrease in requested supports was also noted, with 48.6% (n = 18) requesting some form of academic support in the first week compared to 13.5% (n = 5) at 28 days.Most commonly requested supports across all time points included extra time to complete work, reduced homework, reduced or waived makeup work, and a shortened school day. Received academic support was also greatest in the first week following concussion (40.5%, n = 15) and declined to 16.2% (n = 6) at 28 days.

Conclusions

High rates of academic concerns, requested and received supports were reported in the first week following concussion. A concerning proportion continued to report academic concerns and needs for academic support four weeks after injury. These pilot findings support the need for greater attention to academic effects of concussion and related support in the classroom.

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Head Impact Kinematics do not Predict In-Season Concussion or Lower Extremity Injury in Ice Hockey

Melissa DiFabio; Katherine Breedlove, PhD; Thomas Buckley, PhD

Objective

To examine if head impact kinematics (HIK) predict in-season concussion or acute lower extremity injury (LEI) in collegiate ice hockey.

Background

Sustaining head impacts in sport regularly may be damaging to long-term neurological health. Individuals who sustain higher head impact loads may be at increased risk for concussion, and furthermore, individuals who sustain a concussion are more likely to sustain a subsequent LEI than those without a history of concussion.

Design/Methods

Twenty-nine collegiate club male ice hockey players (age: 20.2 ± 1.4) over the 2015-2018 seasons completed a survey at the conclusion of their season of LEI and concussion in-season. HIK (number of impacts, and mean, peak, and cumulative linear acceleration) were recorded via tri-axial accelerometers (Triax, Nowalk, CT) that each player wore for games/practices with a 10g impact threshold. Two binary logistic regressions were performed to determine if either sustaining a concussion or LEI was predicted by HIK.

Results

There was no relationship between LEI or concussion with number of impacts (β:-0.018, p = 0.711, 95% CI:-0.12-0.84; β:-0.039, p = 0.55, 95% CI: -0.21-0.08, respectively), or mean (β:0.041, p = 0.79, 95% CI: -0.26-0.38; β:-0.040, p = 0.81, 95% CI: -0.37-0.32), peak (β:-0.065, p = 0.14, 95% CI: -0.16-0.01; β:0.0007, p = 0.99, 95% CI: -0.09-0.09), or cumulative acceleration (β:0.001, p = 0.42, 95% CI: -0.001-0.004; β:0.001, p = 0.55, 95% CI:-0.002-0.005). 7/29 players sustained a LEI and 6/29 sustained a concussion. Mean value for number of impacts was 59.7 ± 49.1 (range:3-171); mean acceleration: 33.9 ± 5.3g (range:22.0-42.22), peak: 71.8 ± 19.0g (range: 30.8-108.4); cumulative: 2,108.5 ± 1,793.8g (range 71.8-6517.2).

Conclusions

The main finding of this study is that greater HIK do not predict whether individuals sustained either an acute LEI or concussion during the season, albeit from a small sample. As HIK load is related to concussion incidence, it is possible HIK load may also be related to LEI, however, these results suggest HIK alone is not related to either in an ice hockey cohort.

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Novel Assessment for Interpreting and Documenting an Absence of Suspicion of Injury Including Protocols based on Recognizable Clinically-Relevant Neurophysiological Methods

Jonathan Vincent; Joseph Clark; Robert Mangine; Aaron Keuhn-Himmler; Kimberly Hasselfeld; Jon Divine; Angelo Colosimo; Enna Selmanovic; Nicole Giordano; Bradley Jacobs

Objective

Our goal was to develop and validate a neurophysiological assessment that provides objective evidence useful for interpreting and documenting an absence of suspicious injury by the sports-neuro community.

Background

As concussion awareness gains public notoriety, the pressure on athletic organizations for timely diagnosis has risen, leading to an increase in assessments detecting brain injuries. Furthermore, legislation has mandated evaluations of suspicious injuries before returning athletes to play. However, validation and standardization of these current tests have been remiss, and their data is often not familiar to athletic trainers.

Design/Methods

We conducted exams on 18 University of Cincinnati athletes from various sports teams. The 18 athletes were assessed after being pulled-from-play, sometimes including failed pulled-from-play, to document the athlete's return-to-play. All 18 athletes were referrals sent by athletic trainers unsure of the presence of neurotrauma. The list of assessments includes: stereopsis measurements, phoria, oculomotor performance, near-point of convergence, pupil responses, visual suppression, and balance.

Results

After examination of the 18 participants, 4 were diagnosed having high suspicion of concussion while the other 14 were cleared to return-to-play. Of the 14 cleared athletes, 0 were found to exhibit any persistent or newly developed symptoms. These results suggest that this assessment can provide useful data for clinical concussive injury evaluation. These demographics can also be examined for developing normative data and increased sensitivity with baselines.

Conclusions

We feel that current concussion assessments for athletic organizations are inadequate. We identified a series of neurophysiological tests that are more clinically-relevant, easy to perform, and document as evidenced from the evaluations used on the University of Cincinnati athletes for diagnostic and return-to-play decisions. This assessment's functionality goes beyond the sideline, providing valuable insight for documenting presence or absence of suspicious injury post-competition. We feel this model has enhanced clinical utility compared to the current widespread concussion sideline assessments.

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Time Tandem Gait (TTG) in Athletes 7–16 Years of Age

Nicole Wong; Jamie Bogle, PhD; David Dodick, MD, FAAN; Jennifer Wethe, PhD; Michael Cebette; Marci Howard; Sarah Oakley Holbert; Amaal Starling, MD

Objective

The goal of the present research was to provide updated normative TTG data for younger athletes and increase understanding of the reliability of the TTG.

Background

Imbalance is a hallmark sign of concussion. The Sport Concussion Assessment Tool (SCAT-3) suggests using the Modified Balance Error Scoring System (mBESS) or Timed Tandem Gait (TTG) to evaluate balance function. TTG instructions indicate that times >14 seconds are abnormal as established in individuals between 16-37 years of age (Schneiders et al., 2010). Currently, there is a lack of normative data for the pediatric population.

Design/Methods

Pre-season TTG data were collected from 363 male and 20 female athletes with no active concussion complaints. The best TTG time out of 4 trials without errors was recorded. In addition, post-season data were collected for 107 male athletes.

Results

Results demonstrated a significant decrease in TTG time with age. Given this improvement, separate expected values were constructed: 7–8 years (21.4 +/− 7 s), 9–10 years (18.56 +/− 6 s), 11–12 years (18 +/− 5 s), 13–14 years (15.8 +/− 4 s), and 15–16 years (14.0 +/− 3 s). Analysis showed a significant improvement in TTG time over the season. Preliminary analysis shows no difference between baseline and post-concussion scores.

Conclusions

These results suggest that TTG time should be established annually. Future research will need to explore the expected amount of change in individuals with post-concussion imbalance.

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Predictors of Post-Concussion Depressive Symptoms in Patients without an Underlying Mood Disorder

Rachel Saban; Aimen Vanood; Gustavo Patino, MD, PhD

Objective

To identify predictors of post-concussion depressive symptoms (PCDS) in patients without baseline depressive symptoms.

Background

Depression is common after concussion and affects quality of life and recovery. To date, the most reliable predictor for development of PCDS is existence of an underlying mood disorder. However, few predictors for PCDS in patients without an underlying mood disorder have been found.

Design/Methods

A systematic search was conducted using PubMed for all original articles on post-concussion syndrome in subjects older than 18 years and depression published up to May 2, 2019. Studies that described baseline characteristics for those with and without post-concussion depression were included. Two independent authors reviewed all titles/abstracts to identify studies that met selection criteria. Studies describing pediatric presentation were excluded.

Results

Post-concussion depressive symptoms appear to be associated with symptoms of the concussion itself and with increased number of symptoms reported. Repeat concussions may also increase the risk of developing depressive symptoms. In those with persistent post-concussive symptoms, symptoms seem to appear in a predictable sequence, such that symptoms later in the sequence are more likely to be present if symptoms earlier in the sequence were already present. As such, patients reporting persistent depressive symptoms were more likely to also report existence of correlated cognitive (difficulty concentrating or remembering, feeling dazed) and somatic (headache, fatigue, sensitivity to noise and/or light) symptoms that appear earlier in sequence (OR 2.2). No association between age and gender and experience of new-onset depressive symptoms following concussion was found.

Conclusions

In patients without underlying depressive symptoms, predictors such as quantity and characterization of post-concussive symptoms may help elucidate patient profiles vulnerable to development of PCDS. Multiple concussions, presence of multiple post-concussive symptoms, and presence of correlated symptoms appear to be predictive. Familiarization with these predictors may lead to earlier detection and optimal treatment of PCDS.

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Differential Effects of Injury Etiology on Pediatric Concussion Recovery

Kat Saba; Jacob Kay, MS; Colt Coffman; Cameron Morrison; Jeff Holloway; Davis Moore

Objective

To investigate the relation between mechanism of injury and pediatric concussion outcomes. We hypothesize that individuals injured during sport (sport related concussions; SRC's) will demonstrate better outcomes than those with non-sport injuries (mild Traumatic Brain Injuries; mTBI's), specifically in terms of clinical symptoms, mental health, cognition, and cardio-autonomic function.

Background

Concussions are a growing health concern; however, little is known how different injury etiologies (sport vs. non-sport) effect recovery. Therefore, it is critical to better understand how different injury etiologies effect recovery from concussion to more efficiently guide clinical practices.

Design/Methods

Data collected from a local pediatric concussion clinic were analyzed. SRC and mTBI participants were matched on key demographics (age, body mass index, education) and injury characteristics (time between injury and clinical evaluations, prior history of concussion, pre- and post-injury physical activity). Clinical symptoms were measured using the Rivermead Post-Concussion Symptom Questionnaire (R-PCS). Mental health was measured using the Beck Youth Inventory of Depression (BYI-D). Cognition was measured using a modified CogState Brain Injury Test Battery. Cardio-autonomic function was assessed via heart rate variability (HRV). Participants were evaluated during the acute phase of injury, and again in the post-acute phase.

Results

At both time points, adolescents with mTBI reported greater clinical and depressive symptoms than those with an SRC (p's < 0.05). During the acute phase, adolescents with SRC and mTBI significantly differed on multiple metrics of heart rate variability (p's < 0.05). There were no group differences in cognition at either time point.

Conclusions

Our results suggest those incurring a SRC may demonstrate better outcomes than those incurring an mTBI. Future longitudinal research including baseline measurements is necessary to determine the validity of these findings.

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Association between Concussion Profiles and Neurocognitive Functioning

Shaetu Datta, MD; James Clugston, MD, MS, CAQSM; Russell Bauer; Zac Houck; Michael Jaffee, MD, FAAN; Moreno Charles

Objective

To examine the relationship between concussion profiles and neurocognitive functioning, as measured by CNS Vital Signs (CNSVS).

Background

The heterogeneity of clinical presentation following concussion poses a challenge for treating clinicians. Kontos and Collins proposed a model in which initial global symptoms delineate into specific clinical trajectories, termed concussion profiles.

Design/Methods

The study was a retrospective, blind review of patient data from a concussion specialty clinic. Clinicians determined if patients met criterion for a profile, and identified the primary profile. One-way ANOVA's were used to determine the overall effect of concussion profile on CNSVS

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multi-test domains. Omega-squared ($\omega 2$) was used as an estimate of the overall effect size: 0.01 (small), 0.06 (medium), 0.14 (large). Hedge's g was used post-hoc to determine the effect size of mean differences between profiles on each domain: 0.2 (small), 0.5 (medium), 0.8 (large).

Results

Data consisted of 88 participants obtained from the UF Concussion and Sports program (median age = 26.5; IQR, 18.0–51.8; 90% Caucasian; Median days since injury = 71, IQR, 38–155). Headache/migraine was the most prevalent primary profile (23%), while cognitive was the least prevalent (8%). The cognitive profile was associated with worse scores on the neurocognitive index ($\omega 2 = 0.008$; g = 0.71–1.04), reaction time ($\omega 2 = 0.081$; g = 0.60–1.21), memory ($\omega 2 = 0.016$; g = 0.50–0.96), psychomotor speed ($\omega 2 = 0.023$; g = 0.34–0.62), complex attention ($\omega 2 = 0.026$; g = 0.30–0.72), and cognitive flexibility ($\omega 2 = 0.029$; g = 0.36–0.65) domains relative to other profiles. The vestibular (g = 0.39–0.83) and anxiety/mood profiles (g = 0.33–0.76) were associated with worse reaction time relative to all other profiles except cognitive. Lastly, the headache/migraine profile was associated with worse complex attention (g = 0.26–0.53) and cognitive flexibility (g = 0.29–0.65) relative to other profiles except cognitive.

Conclusions

The cognitive profile is characterized by global cognitive deficits, while deficits in other profiles are domain-specific. Clinicians should consider the role of non-cognitive profiles when interpreting neurocognitive scores.

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Sex Differences in Performance of a Clinically-Relevant Dual-Task Assessment in Healthy College Students

Nicholas Erdman, AT; Juliana Jimenez; David Howell; Thomas Buckley, PhD; Joseph Hart; Jacob Resch, PhD

Objective

To determine if biological sex influenced performance on a novel dual-task (DT) assessment which consisted of commonly used clinical measures of sport concussion (SC) in healthy college students.

Background

DT assessments consist of motor and cognitive tasks administered simultaneously and show promise as clinical measures of SC.

Design/Methods

Our cross-sectional study included 60 (53.3% female) healthy, recreationally active college students (age = 20.5 ± 1.34 years, height = 171.7 ± 9.33 cm, mass = 69.25 ± 12.23 kg). Participants completed the Standardized Assessment of Concussion (SAC) and timed tandem gait (TTG) test independently (single task [ST]) and concurrently (DT). The revised SAC (45 points) which included a 10-word list was utilized. The TTG composite score was a sum of the average time to completion for each SAC task (3 trials for immediate memory [10-word list], up to 5 trials for the digits-backwards task, and one trial for the months in reverse order and delayed recall tasks). Independent *t*-tests were used to assess for sex differences for SAC and TTG performance during ST and DT administration. 2 × 2 factorial analyses of variance (ANOVA) were used to assess for sex (male, female) by task (ST, DT) interaction effects with effect sizes calculated using Cohen's d. All analyses were assessed at $\alpha = 0.05$.

Results

No sex differences were observed for ST performance of the SAC (males = 37.1 ± 3.45 points, females = 37.4 ± 3.74 points; $t[58] = 0.28$, $p = 0.78$) or TTG (males = 44.3 ± 7.09 seconds, females = 46.1 ± 8.88 seconds; $t[58] = 0.88$, $p = 0.38$). No sex differences were observed for DT performance of the SAC (males = 39.7 ± 4.50 points, females = 39.2 ± 3.12 points; $t[58] = 0.46$, $p = 0.64$) or TTG (males = 52.1 ± 8.56 seconds, females = 52.1 ± 10.28 seconds; $t[58] = 0.02$, $p = 0.98$). No sex by task interaction effects were observed for SAC ($F = 0.74$, $p = 0.39$, $d = 0.23$) or TTG ($F = 1.1$, $p = 0.30$, $d = 0.28$) performance for ST or DT assessment.

Conclusions

Our results indicate that our novel DT assessment was robust to sex differences in healthy college students which supports the utilization of our DT assessment across sexes without adjustment for interpretation.

Study Supported By: NA.
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Preliminary Evidence-Based Recommendations for Return to Learn: a novel pilot study tracking concussion recovery in college students

Zachary Bevilacqua; Mary Kerby; David Fletcher; Zhongxue Chen; Becca Merritt; Megan Huibregtse; Keisuke Kawata

Objective

Investigate the potential factors influencing resolution of chief concussion symptoms in a longitudinal design. Second, assess subjects' perception of their concussion recovery and what types of activities and accommodations appeared beneficial.

Background

Athletes re-entering the academic setting after a concussion is commonly referred as return-to-learn (RTL), which has appeared secondary to the abundantly researched return-to-play protocols implemented ubiquitously. Importantly, every concussed collegiate, adolescent, and pediatric athlete is first and foremost a student-athlete, with "student" holding the emphasis. To date, very few studies have examined the RTL aspect of concussion recovery, and the effects premature classroom attendance may cause.

Design/Methods

Nine concussed, college aged (18-26 years), full-time students were monitored longitudinally throughout their recovery from diagnosis to full symptom-free academic participation. Symptom severity for five prevalent symptoms were recorded 4 times per day, along with a daily phone call to report participant's diet, duration of screen-time usage and music listened to, physical activity participation, and types of classes attended.

Results

Response rates to text messages and phone calls yielded a mean 92% and 93% respectively across the nine subjects. Additionally, five variables were significantly associated with symptom resolution (music, sleep, physical activity, water, and time) ($p = 0.0004$ to $p = 0.036$). Lastly, subjects reported math and computer-oriented courses as the most difficult (33% and 44% respectively). Additional time on assignments/exams and reducing screen brightness were the most beneficial accommodations (66% and 56% respectively).

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Conclusions

Our findings introduce a novel and robust approach to monitoring concussed students throughout their recovery. Furthermore, this methodology is the first to produce holistic evidence-based results concerning reintegrating students to the classroom. Lastly, it appears that dietary and social behaviors can indeed influence symptom resolution.

Study Supported By: Indiana University Bloomington.

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Flying may not affect symptom recovery after concussion in Athletes

Tara Sharma, Julia Kerrigan, David McArthur, et al.

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