Abstracts Accepted for Posters

Characteristics and Assessment of Potential Concussive Events in the UEFA Champions League

Mario P Rotundo

Mario P Rotundo (University College Cork)*; Darek Sokol-Randell (University College Cork); Michael Cusimano (St. Michael's Hospital, Neurosurgery/ Injury Prevention Research Office, University of Toronto); Conor Deasy (Cork University Hospital ED/ Emergency Care Innovation & Research Network)

Introduction
Athletes involved in elite sports such as Association Football (AF) are at a high risk of sustaining Sport-Related Concussion (SRC). The effects of repeated concussive and sub-concussive impacts are detrimental to both athletes and healthcare systems worldwide. The objective of this study is to investigate the characteristics of potential concussions in AF, as well as the quality of SRC assessment with reference to the International Football Association Board (IFAB) and International Conference on Concussion in Sport (ICCS) recommendations.

Methods
A potential concussive event (PCE) is defined as direct head contact resulting in the athlete being unable to immediately resume play in a meaningful capacity following impact. Identification and analysis of PCEs were accomplished through standardized observation of video footage by trained observers throughout 34 matches of the 2019/2020 Men's UEFA CL tournament. Analyzed variables include preceding and circumstantial factors, mechanism of injury, impact location, and number of concussion signs. With respect to PCE assessment, primary outcomes include frequency of professional assessment, duration, and Return-to-Play (RTP) decision.

Results
In 34 matches of the 2019/2020 UEFA CL, we identified 67 PCE incidents. Five incidents involved two PCEs, producing a total of 72 PCEs (2.12 per match, 44.58 per 1000 match hours). Of the 67 PCE incidents, 27 (40.3%) were preceded by an attempt to head the ball. The most common mechanisms of PCE were arm/elbow to head (31.9%, n=23) and head on head (19.4%, n=14). The parieto-temporal region was the most frequently affected region of the head (27.8%, n=20), followed by the occipital (25.0%, n=18) and mandibular regions (20.8%, n=15). The mandibular region was the site of impact most commonly associated with visible signs of concussion (46.7%, n=7), followed by the parieto-temporal region (45.0%, n=9).

Of the 72 PCEs, 13 (18.1%) were assessed by medical personnel. Of these 13 assessments, the majority were under 2 minutes in length (92.3%, n=12). Twenty-four (33.3%) players sustaining a PCE displayed one or more signs of concussion. All players sustaining a PCE returned to play during the same match.

Conclusion
This study has elucidated the circumstances and mechanisms that are associated

with the occurrence of PCEs and suggests that strikes to different regions of the head may be associated with a varying number of concussive signs. The data also demonstrates a lack of adherence to IFAB and ICCS concussion guidelines in the UEFA CL. Improved PCE identification, assessment and RTP decisions may reduce the long-term burden of concussion on athletes and healthcare systems, protect UEFA from future litigation, and promote a culture that is committed to protecting player brain health.

Xiancheng Yu

Yu, Xiancheng*; Ghajari, Mazdak

The injury mechanism of Blast-induced Traumatic Brain Injury (BTBI) is still not well understood. Recent neuropathological analyses of brain tissue from post-mortem cases of BTBI have shown that the brain tissue close to the cerebrospinal fluid (CSF) sustains damage [1]. However, this type of injury has not been observed in Impact-induced Traumatic Brain Injury (ITBI) cases. CSF cavitation is a potential injury mechanism for this type of injury. In this study, we developed a one-dimensional human head surrogate model and exposed it to both typical blast and impact loadings to investigate CSF cavitation. We simplified the human head into a one-dimensional model, consisting of skull, CSF, brain tissue and ventricle. The skull was modelled with acrylic material. The CSF/ventricle was modelled with distilled water, with 8.06 ppm oxygen saturation. The brain tissue was modelled with agar gel with 0.65% concentration, as suggested in previous studies [2]. To capture the bubble formation and collapse in the fluid, a high-speed video camera (Phantom V2511) was used. For blast tests, we used the 60mm-diameter shock tube at Imperial College London. For impact tests, we employed a pendulum impact hammer (3 kg). We attached EPS 50/70 foams with different thicknesses onto the front cap of the surrogate model, which created a typical impact loading acceleration history curve comparable to road traffic and sports collisions. From the high-speed video footage, we observed fluid cavitation phenomenon only in the blast tests. No cavitation was observed in the impact tests. In summary, we showed that fluid cavitation can occur under typical blast loading but not under typical impact loading. A key difference between the impact and blast loadings is the rising edge of the loading. The pressure of blast rises from zero to its peak instantly, generating high-magnitude pressure waves in the surrogate model. When the pressure wave transmits to the contreroup site, it accelerates the skull and initiates a tensile wave in the CSF. If the tensile wave is large enough, cavitation will be produced in the CSF. In contrast, the contact force of impact has a gentle rise. The induced tensile wave is not large enough to cause cavitation in CSF.

References

[1] Shively, S., et al., Lancet Neurol, 2016.
[2] Pervin, F., et al., SEM Proceedings, 2011.

Method to determine motion in anatomical regions of the brain

Andrew Post

Post, Andrew*; Dutrisac, Scott; Xu, Sheng; Rovt, Jennifer; Brien, Susan; Poon, Katherine; Frei, Hanspeter; Petel, Oren; Hoshizaki, Thomas

Introduction: Brain injury occurs from impact induced head and brain motion resulting in damaging strain to the neuronal tissues. These strains occur through the interaction of the kinematics of the head from an impact and the motion of the brain, which is affected by the anatomical material characteristics of the different tissues[1,2]. However, the relationship between impact and the motion of the brain in these unique anatomical regions has yet to be investigated. The purpose of this research was to develop a method to that would allow for the investigation of the mechanics of brain motion in different anatomical regions.

Methods: A post-mortem Human Subject (PMHS) head was impacted for this research. Once the inclusion criteria were met, the head was removed and a MRI performed to confirm the suitability of the brain. Following inclusion, markers were inserted into the brain with the pre-impact MRI used as a guide to target the anatomical regions (Figure 1). An unbiased neck was then attached to the base of the skull so that it could be installed on the linear impactor table. The vasculature was then perfused, and the head and ventricles were perfused with aCSF. For this preliminary dataset, there was one PMHS specimen impacted using a linear impactor. An aluminum rod (13 kg) was propelled into the frontal region using a hard MEP 60 Shore A impactor at velocities from 1 m/s to 4.5 m/s. The markers were monitored through the x-ray system (7500 fps, resolution of 1280 x 960 px, with a pre-roll of 20 ms and a total recording time of 500 ms). Dynamic response of the impact was measured using a DTS 6DX SLICE. A total 54 markers were inserted into the brain, with the results focused on the motion in the thalamus, corpus callosum, cerebellum, and brain stem as well as the frontal, temporal, parietal, and occipital regions.

Results: The thalamus and corpus callosum had the highest y-axis displacement, with the cerebellum, pons, and medulla having lower displacements. Interestingly, the thalamus also had very low x-axis displacement. The displacement profiles of the specific anatomical regions and the general brain responses were unique for each impact velocity, which suggests that the motion in these regions are affected by the mechanical characteristics of the brain tissues (Figure 2).

Conclusions: The method developed was successful in creating and quantifying motion in the brain according to anatomical region. This data demonstrates that the brain has a heterogeneous response to impact specific to anatomical location. These differences have implications for the mechanisms of brain injury and finite element model validation and development.

1. Budday S, et al (2019) Fifty shades of brain: A review on the mechanical testing and modelling of brain tissue. Archives of Computational Methods in Engineering.

2. Post A, et al (2020) A preliminary examination of the relationship between biomechanical measures and structural changes in the brain. TRAUMA

White matter alterations with multimodal training in patients with traumatic brain injury: A case series

Phoebe Imms

Phoebe Imms (ACU)*; Adam Clemente (ACU)*; Juan Dominguez (Deakin University); Govinda Poudel (Australian Catholic University); Karen caeyenberghs (Deakin University)

*Co-first authors

Introduction:

Patients with Traumatic Brain Injury (TBI) often show long-term attentional deficits (Rabinowitz & Levin, 2014). This case series tests whether lapses in selective attention improve following a novel home-based combined cognitive and motor training program (CogMo); and explores structural changes of the fronto-parietal attention network using graph theory and fixel-based analyses (Raffelt et al., 2015) at the individual patient level.

Methods:

CogMo training lasted for 6 weeks (3-4 30min sessions/week). Pre- and post-training, the global/local task was used to measure attentional lapses (trial reaction time is 2SD greater than mean reaction time), and structural changes were measured using diffusion imaging (voxels=2.3m3, PEdir=R>>L, directions=66, max b-value=3000s/mm2, 7 b0s). Connectivity matrices and fixel metrics (see Figure 1) were created using mrtrix3tissue (v5.2.8; Dhollander et al., 2019; Tournier et al., 2019)

Results:

TBI1 (29yo, F, 15y post-injury, moderate-severe, right frontal and temporal contusions) showed impairments in selective attention. TBI1 only completed 10 training sessions but showed a 43% decrease in the number of attentional lapses. Before training TBI1 lay outside the confidence intervals (CI) of the healthy controls for six graph measures of the fronto-parietal subnetwork (see Figure 2). At the post-test, small changes in all graph metrics meant TBI1 lay completely within the healthy control CI (apart from navigation efficiency). Fibre density increased by 0.43% in the Superior Longitudinal Fasciculus-I (pre: M= 0.389, SD=0.208; post: M= 0.391, SD=0.208), greater than the 0.36% global decrease of fibre-density.

TBI2 (49yo, F, 3y post-injury, moderate-severe, right inferior frontal contusions) also showed impairments in attention. She completed 29 CogMo sessions and showed a 10% decrease in attentional lapses. TBI2 lay outside the healthy control CI in five graph metrics before and after training: Although, after training, resilience increased while global efficiency fell below the healthy average. A negligible 0.09% increase in fibre density was found in the Superior Longitudinal Fasciculus-I (pre: M= 0.394,

SD=0.187; post: M= 0.395; SD=0.189), similar to the 0.05% global increase.

Conclusions: These observations raise questions around the idea of combining graph theory with fixel-level interrogation of fibre integrity to relate cognitive improvements to brain structure.

References: Rabinowitz, AR, & Levin, HS, (2014), Psychiatr Clin North Am, 37(1), 1-11; Raffelt DA, et al., (2015), Neuroimage, 117(1): 40-55; Dhollander, T, Mito, R, Raffelt, D, Connelly, A, (2019), In Proc. Intl. Soc. Mag. Reson. Med (p. 555); Tournier JD, et al., (2019), Neuroimage, 202(1): 116-137; Wasserthal J, Neher P, & Maier-Hein KH, (2018), Neuroimage, 183(1): 239-253.

Using an instrumented human head replica for the study of concussion mechanisms

Nicola Petrone

Nicola Petrone (University of Padova)*; Alberto Faggin (University of Padova); Gianluca Candiotto (University of Padova); Stefano Contento (University of Padova); Giuseppe Zullo (University of Padova); (Mikael Backstrom (Mid Sweden University); Andrey Koptyug (Mid Sweden University)

Introduction

Despite significant improvements in the design of protecting helmet achieved during last decade, the issue of concussions in sports and vehicles is still urgent (Wilcox et al., 2015). Numerical modeling (Kleiven, 2005; Sahoo, Deck and Willinger, 2016) is still the most used approach in head impact dynamics analysis provided that models can be validated against good experimental data (Nahum et al., 1979). Modern helmet technologies are addressing the rotational accelerations correlated with head injury and concussion mechanisms. Availability of the small inertial sensors as well as of additive technologies allowed the development of a first Instrumented Human Head Surrogate (IHHS-1) (Petrone et al., 2018) and of a second version of the head (IHHS-2) that was validated against cadaveric data in terms of pressure at the CSF fluid and head acceleration (Petrone et al., 2019). The present work aims to report furthers advances in the developments of a physical Instrumented Human Head Replica (IHHR-3) where sensors embedded in the brain will give an insight in the stress/strain state inside the brain during impacts suitable for (i) benchmarking numerical models, (ii) evaluating performances of modern helmets and (iii) gaining medical insight on transients and damage mechanics.

Methods

The IHHR-3 adopts the same geometry of IHHS_2 from digitized computer tomography. Improvement involved the full characterization of silicone gel PlatSil Gel OO-20 (Polyconform, Gmbh) for the surrogate brain and the accurate application of arachnoid surrogate around the brain. Different fluids (ranging from 0,66 to 48 cSt) were compared in sphere drop tests (Figure 1.a,b) for selecting the surrogate CSF. The spherical specimen consisted in an outer spherical shell equipped with an internal pressure sensor (MS5401-AM TE Conn), inner rubber “brain” sphere equipped with triaxial accelerometer (ADXL377 An Dev). The drop test setup allowed to collect pressure and acceleration signals. The same miniaturized accelerometers and pressure sensors were embedded in the brain for measuring the instantaneous strain/stress state in multidirectional impacts after dynamic calibration (20%strain at 10Hz) of cubic samples of 50x50x30 mm (Figure 2.a,b).

Results

Fluids of very different viscosity showed a small influence of surrogate CSF properties on the intracranial pressure, as shown in Figure 1.c for the same drop tests comparing Oil (48 cSt) and Water/Glycerol (0,89 cSt) in the spherical drop tests. Calibrated strain sensors at brain known locations will produce signals that can be provided as benchmark results to corresponding numerical models (Figure 2c).

Conclusions

Advances in the physical modeling of the human head open new frontiers in the cross-validation of physical replicas and computer-based models as well as better understanding of the head injury mechanisms, to support the development of better protection devices and strategies.

Head impact location analysis in collegiate women's soccer indicates a lack of heading in practice may increases sub-concussive exposure

Rebecca Kenny

Rebecca Kenny (University of British Columbia); Allegra Passacantilli (University of British Columbia)*; Marko Elez (University of British Columbia); Sandra Wong (University of British Columbia); Naznin Virji-Babul (The University of British Columbia)

Introduction

Heading is an important part of soccer, yet research has indicated that the cumulative effects of repetitive heading may cause sub-concussive injury (Koerte et al., 2015). Studies have shown that optimal headers near the top of the forehead result in lower linear and angular acceleration than headers on the top or sides of the head (Hanlon & Bir, 2012). In practice, headers are routinely practiced with an emphasis on hitting the ball squarely with the top of the forehead. In games, players are more focused on the outcome rather than on skill development, resulting in less focus on heading technique. The purpose of the study was to evaluate the effectiveness of current soccer practices on promoting the optimal heading in games.

Methods

A women's Varsity team, consisting of 21 players from the University of British Columbia, was followed for the length of their season. Practice and game video footage were analyzed to determine two key factors: 1) delivery of the ball and 2) ball impact location. Ball delivery was either short kick (<10 yards), long kick (>10 yards), overhead throw, player, ground, or other. Ball impact location was coded as either forehead contact (hit), or top, side or back of the head contact (miss).

Results

A total of 1154 head impacts were recorded during 21 games played. In contrast, only 316 head impacts were recorded in practice. The analysis of the ball delivery method revealed that 48.0% ± 3.0% of all headers in games resulted from a long kick, as compared to other types of ball delivery. The analysis of head impact location in games revealed 43% of head impact resulted in a HIT while 53% resulted in a MISS (7% unknown).

Conclusions

In soccer, players purposely and voluntarily use their heads to manipulate the ball and are exposed to a high number of head impacts over the course of a season. The large number of headers have the potential to lead to sub-concussive effects on the brain. Our results show that headers impacting the top, sides and back of the head are common during games. If optimal headers contacting the forehead can reduce linear and angular acceleration of the brain during head impact, increasing the percentage of optimal headers in-game may reduce the risk of brain injury in players. During practice, players are in a controlled setting and can mentally prepare themselves to head the ball, focusing on proper technique. Ball delivery can be unpredictable and optimizing simulation of game scenarios when training could potentially increase the percentage of optimal headers in games. This study provides

the foundation for coaches to structure their practice.

References:

Hanlon, E. M., & Bir, C. A. (2012). Real-time head acceleration measurement in girls' youth soccer. Medicine & Science in Sports & Exercise, 44(6), 1102-1108.
Koerte, I. K., Lin, A. P., Willems, A., Muehlmann, M., et al., (2015). A review of neuroimaging findings in repetitive brain trauma. Brain Pathology, 25(3), 318-349.

Intestinal Inflammation Following Chronic Experimental Traumatic Brain Injury in Mice Induces Persistent Neurobehavioral Deficits, Systemic Inflammation and Dysautonomia

Marie Hanscom

Authors and Affiliations: Marie Hanscom[1], David J. Loane [1,2], Terez Shea-Donohue*[1], Alan I. Faden*[1].

1 University of Maryland School of Medicine, Baltimore, Maryland; 2 School of Biochemistry and Immunology, Trinity Biomedical Sciences Institute, Trinity College, Dublin, Ireland.

* Co-senior author.

Introduction

Disruptions in the bidirectional communications of the brain-gut axis are increasingly implicated in the onset and progression of a variety of gastrointestinal and neurological disorders, diseases, and injuries including traumatic brain injury. We previously found that intestinal inflammation induced by an enteric pathogen following experimental TBI in mice exacerbated brain injury lesion volume. The aims of this preclinical study were to determine: 1) the effect of intestinal inflammation following chronic TBI on neurobehavioral and neuropathological outcomes 2) the potential involvement of the neural and systemic communication pathways of the brain-gut axis.

Methods

Male C576Bl/6 male mice were randomized into naïve (anesthetic), sham (craniotomy), or controlled cortical impact (CCI) groups. At 28 days post injury, mice from each group were administered 3% dextran sodium sulfate (DSS) via drinking water for 7 days, followed by return to regular water for up to 28 days (n=14-21 per group). Throughout the study, mice underwent electrocardiography for heart-rate variability (HRV) analyses and behavioral testing to assess motor (beam walk, BW) and cognitive function (novel object recognition, NOR) and social behavior (social approach, SA). At 7 days post-DSS, brains were collected for histological analyses. Blood, spleens, and mesenteric lymph nodes (mLN) were collected at 28 days post-DSS for immune characterization via flow cytometry.

Results

Intestinal inflammation following chronic TBI resulted in an exacerbation of TBI-induced deficits in fine motor coordination (BW) and social recognition/memory (SA). In Sham-injured mice, intestinal inflammation induced persistent deficits in fine motor coordination (BW), declarative memory (NOR), social recognition/memory (SA). Intestinal inflammation also resulted in increased hippocampal neurodegeneration in Sham and TBI mice. Myeloid cells were increased in the spleen, while myeloid cells and T-cells were elevated in mLN in all DSS mice. Sham+DSS and TBI+DSS mice exhibited increased sympathetic tone (HRV) up to 7 days post-DSS.

Conclusions

These data show that intestinal inflammation following chronic TBI results in a persistent induction in (Sham) or exacerbation (CCI) of TBI-associated neurobehavioral deficits, as well as, a sustained extra-local and systemic immune response and persistent alteration of autonomic balance in favor of sympathetic dominance. Combined, these findings suggest that disruption of the cholinergic anti-inflammatory via alteration of the vagal-spleen axis contributes to intestinal inflammation induced exacerbation of TBI-associated neurological dysfunction.

Combatting the neurometabolic cascade of concussion using transcranial direct current stimulation: A review

Justin Buttar

Buttar, Justin*; Virji-Babul, Naznin

Introduction:
Sports-related concussion (SRC) is a debilitating injury in athletics. Despite our understanding of the neurometabolic cascade in concussion pathology, current treatments ineffectively address it. [1] Transcranial direct current stimulation (tDCS) has been introduced as a non-invasive brain stimulation therapy but its role remains unclear. Compiling investigations using tDCS in SRCs will help define its mechanism of action and may further its endorsement in concussion management.

Methods:
Using the MEDLINE extraction software, peer reviewed manuscripts citing “transcranial direct current stimulation” and “sports related concussion” from Jan 1, 2000 to April 1, 2020 were compiled. tDCS in contexts other than SRC were included if their objectives involved “remyelination” or “strengthening neuronal synapses.”

Results:
16 out of 22 identified articles were analyzed. Calcium imaging in a mouse model revealed tDCS can stimulate glial cells, which help supply nutrients and oxygen to neurons. [2] tDCS may stimulate endothelial cells, increasing release of local vasodilatory factors. [3] tDCS improved cerebral blood flow (CBF) and blood volume in all 20 patients with mild traumatic brain injury. [4] tDCS improved the synchronicity of neuronal firing, improving the dysfunctional neural network in SRC. [5]

Conclusions:
tDCS is uniquely able to directly combat the neurometabolic cascade in SRC. Particularly, tDCS can improve CBF, combat diffuse axonal injury and improve inter-regional synapsing. tDCS stimulates glial cells which bolsters the remyelination process and remedies pathological GABA levels. In summary, tDCS is a promising treatment in SRCs due to its direct and robust mechanism of action.

References
1: Giza CC, Hovda DA. (2014). The New Neurometabolic Cascade of Concussion. Neurosurgery. 75(4): S24-31.
2: Monai H, Ohkura M, Oe Y, Konno A et al ., (2016). Calcium Imaging reveals glial involvement in transcranial direct current stimulation-induced plasticity in mouse brain. Nature, 7(1); 111000.
3: Pulgar VM. (2015). Direct electrical stimulation to increase cerebrovascular function. Front Syst Neurosci, 9:54.
4: Trofimov AO, Kalentiev G, Karelsky M, Ksenofontova C et al., (2018). Cerebral Hemodynamics after Transcranial Direct Current Stimulation (tDCS) in Patients with Consequences of Traumatic Brain Injury. Oxygen Transport to Tissue, 1072: 59-62.
5: Kim HJ, Han SJ. (2017). Anodal Transcranial Direct Current Stimulation Provokes Neuroplasticity in Repetitive Mild Traumatic Brain Injury in Rats. Neural Plast, 2017: 1372946. doi: 10.1155/2017/1372946

Characteristic patterns of white matter tract injury in sport-related concussion: An image based meta-analysis

Sarah C Hellewell

Authors & Affiliations: Sarah Hellewell*, Thomas Welton*, Vy Nguyen*, Ruchira Jaysena*, Stuart Grieve*^
*University of Sydney, Australia; ^Department of Radiology, Royal Prince Alfred Hospital, Sydney, Australia

Introduction

Sports-related concussion (SRC) is sustained by millions per year (Langlois, Rutland-Brown et al. 2006), yet the spatiotemporal patterns of WM injury are unclear. Several SRC studies have implemented the standardised approach Tract-Based Spatial Statistics (TBSS) (Smith, Jenkinson et al. 2006). Our image-based meta-analysis aimed to identify consensus patterns of WM injury across TBSS studies in SRC.

Methods

We included studies comparing fractional anisotropy (FA) in SRC to controls using TBSS. “White matter” “mTBI OR concussion” and “TBSS” were searched in Google Scholar, Web of Science & PubMed. Authors were contacted to request unthresholded statistical T-maps from TBSS, and image-based meta-analyses were performed using Seed-Based D-Mapping (Radua, Mataix-Cols et al. 2012). We conducted 4 voxel-wise meta-analyses to examine WM abnormality in SRC as well as sub-concussive hits, and SRC in the acute and chronic recovery phase (months-to-years post-injury).

Results

We found 8 studies comprising 174 SRC participants and 160 controls. 2 examined subconcussive hits without overt SRC, 2 recruited subjects within 28h of SRC and 4 examined participants chronically.

FA in SRC vs control: 21 positive clusters were identified. There were bilateral regions of concordance in the superior longitudinal fasciculus (SLF), arcuate fasciculus (AF), retrolenticular part of the internal capsule (RIC), inferior fronto-occipital fasciculus (IFOF) and inferior longitudinal fasciculus (Fig 1). Of these, two dominant clusters were located in the right SLF (178 voxels) and RIC (128 voxels).

FA in subconcussive vs control: 3 small clusters were found: two were positive and located in the posterior segment of the left AF (12 voxels), and one negative (13 voxels) in the anterior segment of the right AF.

FA in acute SRC vs control: 8 small positive bilateral clusters were found in acute SRC when compared to controls, in the superficial WM (Fig 2). The largest clusters were in the SLF (R: two clusters of 18 voxels; L: 12 voxels) and right IFOF (16

voxels).

FA in chronic SRC vs control: 16 positive clusters were found in chronic SRC (Fig. 2). These clusters were in the deep WM, and dominant in the right optic radiations (126 voxels) and AF (94 voxels). Smaller midline clusters were also detected in the corpus callosum, cingulate and internal capsule (20-23 voxels).

Conclusions

Our findings show that TBSS is sensitive to SRC-related WM abnormalities over a range of temporal and clinical scenarios. Our data show concordant pathological features unique to subconcussive, acute concussive and chronic post-concussive phases, highlighting the utility of diffusion MRI for SRC diagnosis.

Characterizing the Risk of Depression Following Mild Traumatic Brain Injury: A Meta-Analysis of the Literature Comparing Chronic mTBI to Non-mTBI Populations

Sarah C Hellewell

"Authors and Affiliations: Sarah Hellewell*, Caerwen Beaton*, Thomas Welton*, Stuart Grieve*^

*Imaging and Phenotyping Laboratory, University of Sydney, Australia

^Department of Radiology, Royal Prince Alfred Hospital, Sydney, Australia

Introduction

Mild traumatic brain injury (mTBI) is associated with depressed mood acutely

post-injury, but there is little evidence regarding long-term depression. The aim of this meta-analysis was to determine the odds ratio (OR) of depression chronically following mTBI.

Methods

We searched Medline (PubMed), ProQuest, and Web of Science from date of database creation to January 23, 2019, for eligible studies examining depression at least 6 months post-injury in adult subjects with mTBI of any etiology, including civilians and military. Three authors independently reviewed titles and abstracts for study eligibility. Data were extracted and collated by two investigators. Risk of bias was assessed with the SIGN methodology. Study data were pooled using random-effects meta-analysis. The primary exposure was mTBI, and the primary outcome was depression. Secondary exploratory variables were time of assessment, age at injury, age at assessment, sex, and etiology.

Results

We included 47 cross-sectional studies (n = 25,103 mTBI and 29,982 control), 26 cohort studies (n = 70,119 mTBI, 262,034 control), four prospective observational studies (n = 1,058 mTBI and 733 control), two prospective longitudinal studies (n = 119 mTBI, 81 control), two case-control studies (n = 56 mTBI, 56 control), and one randomized controlled trial (n = 252 mTBI, 3,214 control). mTBI was associated with a 3.29-fold increased risk of depression (OR 3.29, 95% CI 2.68–4.03, I2 = 96%). The OR for depression did not change when subjects were assessed at 6–12 months (OR 2.43, 1.45–4.07), years 1–2 (OR 4.12, 2.10–8.07); 2–10 (OR 3.28, 2.42–4.46), or 10+ (OR 3.42, 1.51–7.77). Similar risk of depression was sustained across different age at injury (<25: OR 2.26, 1.82–2.81; 25–35: OR 4.67, 3.06–7.14; >35: OR 2.69, 1.42–5.10) and different age at assessment (<40 years: OR 3.14, 2.48–3.99; >40 years: OR 4.57, 2.54–8.24). Female sex had a non-significant increase in

OR (OR 19.97, 2.39–166.93) compared to male (OR 3.0, 2.33–3.86). mTBI etiology had no impact on depression.

Conclusions

Those experiencing mTBI are more than three times more likely to experience depression compared to those without a history of mTBI, and this risk remains decades beyond the mTBI event. Future longitudinal studies are needed to identify and mitigate this risk."

Objective measurement of head impacts through video observation is required for accurate assessment of head exposure in female collegiate soccer

Allegra Passacantilli

Rebecca Kenny (University of British Columbia); Allegra Passacantilli (University of British Columbia)*; Marko Elez (University of British Columbia); Sandra Wong (University of British Columbia); Naznin Virji-Babul (The University of British Columbia)

Introduction

Soccer is one of the most played sports in the world and there is growing concern about the effects of heading on long term brain health (Moore, Lepine & Ellemberg, 2017). Self-reports are commonly used to assess the number of headers performed by each player; however, such reports are often inaccurate, particularly in youth (Harriss, Walton & Dickey, 2018). Quantitative methods of evaluating the number of headers is essential to determine the exposure of headers on players throughout the season and on their careers. The purpose of this study is to compare direct player observation with self-report in collegiate soccer. It is hypothesized that self-report is not an accurate assessment of heading exposure at the collegiate level.

Methods

10 female varsity soccer athletes from the University of British Columbia's Varsity soccer team were recruited. The study took place over the course of a single competitive season, consisting of 21 regular season and playoff games over the course of 3 months. All games were videotaped, and the number of headers recorded from games video analysis was analyzed. At the end of the season, all players were requested recall on the average number of times they headed the ball at each game. The self-report number of average headers was then multiplied by the number of games each player was involved in to compare to the total number video recorded headers in the season. The total number of self-reported headers was compared to the total number of video-recorded headers.

Results

The total number of headers obtained from the video analysis for each player was between 1 and 148 (mean=71.5 ± 42.29). The total number of self-reported headers ranged from 5 to 200 (mean=92.80 ± 48.28). A correlation coefficient of r=0.78 revealed a moderate positive linear relationship between the two variables. Findings showed that 2 of the players underestimated the number of headers (mean=27.5), while 8 of the players overestimated (mean=33.5) headers. Linear regression analysis revealed that players overestimated the number of headers by 68%.

Conclusions

Our data suggests that overall, self-report by players does not provide an accurate assessment of the number of headers performed by players. Players both significantly overestimated and underestimated the number of headers performed. Direct player observation using video analysis should be incorporated along with the self-reports in order to more objectively evaluate the effects of heading on brain health.

References:
Harriss, A., Walton, D. M., & Dickey, J. P. (2018). Direct player observation is needed to accurately quantify heading frequency in youth soccer. Research in sports medicine, 26(2): 191-198.
Moore, R. D., Lepine, J., & Ellemberg, D. (2017). The independent influence of concussive and sub-concussive impacts on soccer players' neurophysiological and neuropsychological function. International journal of psychophysiology, 112: 22-30.

Predictors of poor outcome of pediatric gunshot head injury: a brazilian single center experience

Pedro Lukas do Rêgo Aquino

Pedro Lukas do Rêgo Aquino (University of Pernambuco)*; Luiz Severo Bem Junior (Hospital da Restauração); Maria Améllia do Rêgo Aquino (Federal University of Pernambuco); Luís Felipe Gonçalves de Lima (Unifacisa); Júlio Cesár Tavares Marques (Unifacisa); Artêmio José Araruna Dias (Unifacisa); Andrey Maia Silva Diniz (Federal University of Paraiba); Hildo Rocha Cirne De Azevedo (Hospital da Restauração)

Author and Affiliations:
1- Pedro Lukas do Rêgo Aquino – Faculty of Medical Science, University of Pernambuco
2- Luis Severo Bem Junior – Neurosurgery Department, Hospital da Restauração
3- Maria Améllia do Rêgo Aquino – Faculty of Medical Science, Federal University of Pernambuco
4- Luís Felipe Gonçalves de Lima – Medical Sciences College, Unifacisa
5- Júlio Cesár Tavares Marques – Medical Sciences College, Unifacisa
6- Artêmio José Araruna Dias – Medical Sciences College, Unifacisa
7- Andrey Maia Silva Diniz - Faculty of Medical Science, Federal University of Paraiba
8- Hildo Rocha Cirne de Azevedo - Neurosurgery Department, Hospital da Restauração

Introduction

This article aims to evaluate the predictive factors of morbidity and mortality in pediatrics patients who suffered gunshot wounds to the head. We reviewed a series of 43 patients admitted to the Hospital da Restauração, Recife, Brazil, between 2010 to 2019.

Methods

Data from 43 patients who underwent surgical treatment in our institution. The following parameters were considered in the data analysis: the initial Glasgow Coma Scale (GCS), age, sex, bullet entry site, bullet trajectory, computed tomography (CT) scans at admission, complications, midline crossing, and Glasgow Score Scale at discharge (GOS). Pearson's Chi-square test or the Fisher's exact test were used. The data was entered in the EXCEL worksheet and the program used to obtain the statistical calculations was IBM SPSS in version 23.

Results

The male gender corresponded 90,7% of the cases (N=39) and the mean age was 16,5 years (60,5%). The frontal region was the most common entry site (41.9%), following by parietal wall (27.9%), and occipital region (20.9%). Penetrating trajectory was showed in 48.8%, perforating/transfixing in 39.5% and tangential in 11.6%. CT scan showed sinking as the most common alteration (74.4%), following by cerebral contusion (44.2%), and cerebral hemorrhage (34.9%). According to GOS 23.3% were classified as an unfavorable outcome (GOS: 2 to 3) and 53.5% as a favorable

outcome (GOS: 4 and 5). The mortality rate was 23.3%. In our study there was a significant association between the low GCS scores on admission and low GOS (1 to 3) (p 0.001). The patients who presented wound crossing the midline also had a significant association with low GOS (p 0.014) in our clinical experience.

Conclusions

We conclude that low GCS scores at admission and children with a wound that crosses the midline are predictive factors of high mortality and morbidity, in our clinical experience.

References

1.Martins RS, Siqueira MG, Santos MTS, N Zanon-Collange, et al., (2003). Prognostic factors and treatment of penetrating gunshot wounds to the head. Surg Neurol, 60(2):98-104.
2. Patrick M, Robert C, Michael J. Bell, Adelson PD, et al., (2019). Management of Pediatric Severe Traumatic Brain Injury: 2019 Consensus and Guidelines-Based Algorithm for First and Second Tier Therapies . Pediatr Crit Care Med, 20(3):269–279.

Epidural hematoma of posterior skull base in childhood

Gabriela Fe Kalkmann

Gabriela Fe Kalkmann (Federal University of Paraná)*; Isabela Prado (Federal University of Paraná); Leticia Novak Crestani (UniCesumar); Letícia LA Adrielle (Federal University of Sergipe); Carlos Pereira (Surgical Hospital Charitable Foundation of Sergipe); Joilson Souza Júnior (Federal University of Sergipe); Nícollas Rabelo (Atenas University Center)

Introduction

Epidural hematoma (EH) often occurs in the supratentorial portion, and in particular in the regions temporal and temporoparietal. Epidural hematoma of the posterior fossa (EHPF) in childhood occurs between 1.2% to 15% of EHs. It usually arises after a trauma occipital, suboccipital or retromastoid region. In this location, EH is dangerous due not only to small dimension of the posterior fossa, but also to the direct compression it causes in the brain stem.

Methods

It is a case report of a patient from five-year-old, male. Genitor referred drop from an approximate height of four meters, evolving with vomiting and drowsiness. On examination neurological patient was sleepy. Upon admission, Glasgow Coma Scale (GCS) score of 14, with the both pupils reactives, with no neurological deficit focal. Computed Tomography (CT) of the skull without contrast, the presence of a fracture line right occiput and hyperdense lesion in the region right cerebellar. The patient was submitted to right suboccipital craniectomy for drainage of the hematoma. He was discharged six days after hospitalization, without neurological deficit.

Results

The most common cause of childhood EHPF is falling in height, usually one-sided, more affects the male. Bleeding is from usually of the cranial sinuses (sigmoid and transverse more frequently), posterior branch of the middle meningeal artery or diplomatic veins. The childhood EHPF shows atypical evolution, it can be silent and slow or even deteriorate quickly, causing a high rate of morbidity and mortality. Presence of signs of cerebellar involvement, neck stiffness, nystagmus, oculomotor nerve paresis and drowsiness, associated with occipital fracture or even the presence of a sign of Battle leads to the suspicion of EHPF. Can be associated with contusion, diffuse cerebral edema, subarachnoid hemorrhage and hydrocephalus, being the latter associated with a poor prognosis. CT has been indicated in children with a history trauma due to accidental fall or accident transit that presents swelling or fracture of skull in the occipital region. Treatment is surgical management, but, in selected cases it has been conservative treatment is indicated. Main determinant for the prognosis in these cases has been the GCS score on admission.

Conclusions

The EHPF in children has a good prognosis when it is diagnosed early and treated properly. References: Berker M, Cataltepe O, Ozcan OE, (2003). Traumatic epidural haematoma of the posterior fossa in childhood: 16 new cases and a review of the literature. Br J Neurosurg, 17(3): 226-229. Ciurea AV, Nuteanu L, Simionescu N,

Georgescu S, (1993). Posterior fossa extradural hematomas in children: report of nine cases. Childs Nerv Syst, 9(4): 224-228. Jamjoom A, Cummins B, Jamjoom ZA, (1994). Clinical characteristics of traumatic extradural hematoma: a comparison between children and adults. Neurosurg Rev, 17(3): 277-281.

Retrospective analysis of 19 cases of acute intracranial epidural hematoma treated by resident

Gabriela Fe Kalkmann

Caio de Paula (University Hospital of Sergipe); Gabriela Fe Kalkmann (Federal University of Paraná)*; Isabela Prado (Federal University of Paraná); Letícia LA Adrielle (Federal University of Sergipe); Leticia Novak Crestani (UniCesumar); Carlos Pereira (Surgical Hospital Charitable Foundation of Sergipe); Fernanda Pinheiro (Federal University of Sergipe); Damião Araújo (Federal University of Sergipe)

Introduction: Medical residency is a postgraduate teaching modality, it works in accredited health institutions and obeys regulations from the Ministry of Health and Culture (Brazil). Throughout the residency in neurosurgery, one can perceive the magnitude of traumatic events in the state of Sergipe and the neurosurgical demands of intracranial epidural hematoma (EH). EH is defined as an accumulation and blood between the internal skull and the dura mater. It is considered a neurosurgical emergency. It is usually due to traffic accidents and accidental falls. It is located mainly in the region temporoparietal in about 70 to 80% of cases. It is usually due to the rupture of the middle meningeal artery or its branches during traumatic brain injury (TBI). It occurs in 1 to 2% of TBI. It affects young adults more, with a predominance of sex male.

Methods: The non-probabilistic sample for accessibility was composed of 19 patients between the period from March 2014 to February 2017, operated on by a single resident of neurosurgery. Included were: sex, age, cause of the injury, Glasgow Coma Scale (GCS) on admission, location of hematoma, imaging findings, time surgery, length of hospital stay and complications.

Results: The descriptive analysis of the sample revealed a mean age of 32.4 years (standard deviation (SD) ± 11.1), with a mean of 19 days of hospital stay and surgical time 2.7 hours (SD ± 0.9). Of the nineteen cases, eight required postoperative care in the intensive care unity with an average hospital stay of 9.4 days (SD ± 13.1). It was identified that 89.3% of the patients were male, and victims of motorcycle accident (63.1%). In the neurological examination of the admission, most of them presented Richmond Agitation-Sedation Scale 5 (21%) and GCS 15 (21%). All cases had hospital discharge as an outcome.

Conclusions: Medical residency is paramount importance in professional training. The result of surgical treatment of EH is similar to that of the preceptors of the resident's formation. It is evident are the benefits for patients, who receive appropriate treatment, even if this treatment is performed by a neurosurgeon in formation.

References: Agrawal A, Agrawal CS, Kumar A, Adhikari S, (2007). Outcome of traumatic extradural haematoma managed surgically. Our experience. NJOT, 6(2): 74-76. Tavares CB, Sousa EB, Chagas F, Braga SAG et al., (2014). Perfil epidemiológico de pacientes com hematoma extradural agudo tratados cirurgicamente no Hospital de Base do Distrito Federal, Brasilia, Brasil. Brasilia Med, 51(1): 32-35. Babu ML, Bhasin SK, Kumar A, (2005). Extradural hematoma – An experience of 300 cases. JK Sciences, 7(4): 205-207. Pereira CU, Silva EAS, Dias LAA, (2004). Hematoma extradural intracraniano: correlação entre o volume do hematoma com a localização e idade do paciente. J Bras Neurocir, 15(2): 59-62.

Instrumented Mouthguards Validation in Measuring Head Kinematics and Brain Deformation

Yuzhe Liu

Yuzhe Liu[1],*, August G. Domel[1],*, S. A. Yousefsani[1],*, Jovana Kondic[1,6], Gerald Grant[2,3], Michael Zeineh[4], David B. Camarillo[1,2,5,^]
1 Department of Bioengineering, Stanford University, Stanford, CA, 94305, USA.
2 Department of Neurosurgery, Stanford University, Stanford, CA, 94305, USA.
3 Department of Neurology, Stanford University, Stanford, CA, 94305, USA.
4 Department of Radiology, Stanford University, Stanford, CA, 94305, USA.
5 Department of Mechanical Engineering, Stanford University, Stanford, CA, 94305, USA.
6 Department of Electrical Engineering, Princeton University, Princeton, NJ, 08540, USA.
* These authors had equal contribution.
^Corresponding author (e-mail: dcamarillo@stanford.edu).

Introduction

In order to better understand the underlying biomechanics associated with concussions and how these affect brain health, researchers have turned to wearable technologies to gather head impact kinematic data from athletes, especially in football. It has been recently shown that because of the relatively rigid coupling between the upper dentition and the skull, instrumented mouthguards are a very accurate way of measuring head impact kinematics compared to other traditional wearable technologies. This has led various companies and institutions to develop instrumented mouthguards for measuring head kinematics in sports, including football. However, it is important to understand the accuracy of these instrumented mouthguards that are being used as a research tool to understand concussive impacts.

Methods

We present a study that uses a pneumatic impactor to deliver football impacts (5 locations: Facemask, Front, Oblique, Side and Back, 4 velocities: 3.6, 5.5, 7.4, 9.3 m/s) to a hybrid III anthropomorphic test dummy headform in order to validate 5 commonly used instrumented mouthguards: Stanford customized (MiG-C) and boiling-and-bite (MiG-B) mouthguards; Prevent customized (PRE-C) and boiling-and-bite (PRE-B), and Sports & Wellbeing Analytics customized (SWA-C) mouthguard against the reference headform sensors. We quantify the validity of the instrumented mouthguard by comparing the peak of kinematics, the correlation of the traces, and the direction of the head movement. Then we calculate the error in brain deformation and brain injury criteria.

Results

The peak of kinematics given by the mouthguards are compared with the reference data in the Fig.1, and the relative error are compared in Fig.2. The mean relative errors of the peak angular velocity, brain strain (only the mouthguards with time

windows>100ms) and the brain injury criteria are smaller than 8%, 9% and 13%, respectively. We also found that the accuracy of measurement varies with the impact locations, and is not sensitive to the impact velocity except the saturation of the gyroscope.

Conclusions

The tested instrumented mouthguards are able to be used in the football game to measure the head kinematics, predict the brain strain, and monitor the risk of the brain injury.

Epidemiology of primary early decompressive craniectomies performed in a reference neurosurgery hospital in Brazil

Andrey Maia Silva Diniz

Andrey Maia Silva Diniz (Federal University of Paraiba)*; Ana Cristina Veiga Silva (Hospital da Restauração); Maria Améllia do Rêgo Aquino (Federal University of Pernambuco); Luís Felipe Gonçalves de Lima (Unifacisa); Júlio Cesár Tavares Marques (Unifacisa); Artêmio José Araruna Dias (Unifacisa); Pedro Lukas do Rêgo Aquino (University of Pernambuco); Lucas Mendes da Mota (FIMCA); Lucas Ribeiro de Moraes Freitas (Federal University of Paraiba); Victor Ribeiro Xavier Costa (FCM-PB); Luiz Severo Bem Junior (Hospital da Restauração); Hildo Rocha Cirne De Azevedo (Hospital da Restauração)

Introduction

Severe head trauma can lead to brain swelling, increased intracranial pressure (ICP), reduced cerebral blood flow, inadequate O2 delivery, ischemia, metabolic failure and further brain edema. A major principle in managing severe traumatic brain injury (TBI) is based on strategies to control intracranial pressure and an adequate cerebral perfusion pressure (CPP). Decompressive craniectomy (DC) enlarges the intracranial space, allowing the swollen cerebral hemisphere to expand out of normal cranial limits. The gain in intracranial volume as a result of the surgery results in the improvement of cerebral compliance, a reduction in ICP, and an increase in CPP, favoring a rise in both cerebral blood flow and cerebral microvascular perfusion. The role of DC in the treatment of refractory posttraumatic intracranial hypertension remains controversial despite current guidelines discourage DC as a first-line therapy. This study analyzes the early (within 24 hours) and ultra-early (6 to 12 hours) DC as an effective form of management for severe TBI.

Methods

Retrospective cohort from a database of 35 patients who underwent surgical DC in our institution. The data analysis considered: personal profile, lesion characteristics, clinic profile, surgical characteristics, post-operative situation and complications and initial Glasgow Coma Scale. Pearson's Chi-square test, the Fisher's exact test, Poisson Regression Model, Wald test were used. Bivariate and multivariate analysis was performed.

Results

The prevalence was higher in patients admitted in severe condition, with a score of 3 to 8 points (60%), followed by the group with 9 to 12 points (22.9%) and 13 to 15 points (17.1%). The proportion comparison test was significant (p-value = 0.003). In the management, the presence of primary DC is found in 88.9% of the cases, the duraplasty was performed in 55.6% of the interventions, the monitoring of the ICP was instituted in only 5.6% of the patients and the flap bone was discarded in 74.3% of cases. It was observed that the majority of patients had surgical intervention performed within 12 hours of admission, these patients, still, had a substantially

lower average age, had severe Glasgow in the initial evaluation and were, for the most part, hospitalized for TBI when compared to those who waited 12 hours or more for surgery. Regarding the clinical outcome, there was no statistically significant difference.

Conclusions

Upon analyzing the results found in the retrospective cohort, it was found that patients who underwent DC in less than 12 hours were of greater severity and younger than the others. A similar outcome was observed between the group operated on for less than 12 hours and those who underwent DC after that time. In this way, it is concluded that the early DC has good efficacy for reduction of the PIC.

References:

1. Wang JW, Li JP, Song YL, et al., (2016) Decompressive craniectomy in neurocritical care. J Clin Neurosci.,27:1-7.

Surgical Outcome of Geriatric Traumatic Brain Injury

Pooja A Hazare

Hazare, Pooja A*; Thombre, Bhushan; Jayan, Mini; Pateriya, Vibhor; Patel, Kautilya; Indira Devi, Bhagavatula; Shukla, Dhaval P; Konar, Subhas

Introduction
Increasing patient age is strongly associated with a rising incidence of traumatic brain injury
(TBI) and a higher mortality and morbidity rates. In developing country with limited resources for perioperative treatment, the decisions on surgical treatment in these patients are generally difficult and depend on operating surgeons' experience, as well as from
institutional and social background of patient. The aim of this study was to identify the
predictors of mortality and unfavorable outcome after craniotomy for TBI in elderly patients.

Methods
Data of all patients aged ≥65 years who underwent craniotomy for acute TBI, over a period
from January 1, 2015, to October 2019 were retrospectively reviewed. The standard clinical
and imaging variables for TBI were recorded. The medical comorbidities, indication for
surgery, and intraoperative complications were also recorded. The outcome of interest was
survival at six months after surgery.

Results
In our institute's registry of TBI in 2005 there were 5.2% patients older than 60 years, and in
2015 it rose to 9.6%. During the study period a total of 7544 patients underwent surgery for
acute trauma out which 265 (3.5%) were older adults (age ≥65 years). A total of 206 patients
were available for analysis. The age of patients ranged from 65 to 80 years. The commonest
surgical procedure performed was craniotomy and evacuation of supratentorial subdural
hematoma (SDH) with or without evacuation of traumatic parenchymal lesion.

The in-hospital mortality was 46 out of 206 (22.3%), and six months mortality was 116 out of 206 (56.3%). Among the 90 survivors at six months, GOS was available for 81 (90%)
patients. Good recovery was seen in 57 (70.5%), moderate disability in 16 (19.8%), and
severe disability in 7 (8.6%) patients. Only one (1.2%) patient survived in vegetative

state at
six months.

On univariate analysis the significant clinical predictors of outcome were GCS, motor score,
pupillary reaction, and presence of medical comorbidities particularly diabetes mellitus. None of the patients with GCS 3 or 4 survived. Only one patient who had bilaterally dilated pupil, and he did not survive. On CT scan presence of traumatic subarachnoid hemorrhage (SAH) was associated with higher mortality (tables 1-3). Patients who underwent surgery for
supratentorial SDH and traumatic parenchymal lesion had higher mortality. Six patients
underwent reoperation for evacuation of ipsilateral haematoma, and all six died.

Conclusions
In older adults the main determinant of survival after surgery for TBI are GCS, motor score,
pupillary reaction, presence of medical comorbidities, traumatic SAH, surgery for SDH and
contusions, and need for reoperation.

Mild Traumatic Brain Injury in the elderly: can it really be defined as “Mild”?

Rebeca Alejandra Gavrila Laic

Rebeca Alejandra Gavrila Laic (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium)*; Dominike Bruyninckx (Research Group Experimental Neurosurgery and Neuroanatomy, Department of Neurosciences, KU Leuven, Leuven, Belgium); Phaedra Lebegge (Research Group Experimental Neurosurgery and Neuroanatomy, Department of Neurosciences, KU Leuven, Leuven, Belgium); Jos Vander Sloten (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium); Bart Depreitere (Research Group Experimental Neurosurgery and Neuroanatomy, Department of Neurosciences, KU Leuven, Leuven, Belgium)

Introduction
Traumatic Brain Injury (TBI) in the elderly, mainly caused by fall accidents associated to the increased activity in this population, has been raising dramatically over the last two decades 1. It is known that ageing leads to the reduction of the overall physiological reserve capacity and psychosocial changes in later life, which are factors that worsen recovery 2 . However, despite its importance for society, the impact of TBI in the elderly is still not well understood. Therefore, our aim is to evaluate the impact of Mild TBI, defined by a Glasgow Coma Scale (GCS) 13-15, in the elderly population in terms of cognitive and motor functions, dependency and mortality.

Methods
Clinical histories of 384 patients ≥ 65 years old admitted to the University Hospital Leuven (Belgium) after sustaining TBI from 1999-2018 with a GCS 13-15, were manually screened. Data regarding age, sex, injury patterns, GCS at hospital admission, cognitive and motor functions, diagnosis of neurodegenerative disease after TBI, dependency and mortality was registered. Patient follow up ranged between 1 day and 20 years after the injury. Statistical analysis was performed with the Python Data Analysis Library (pandas).

Results
In 77% of our cases TBI was caused by a fall accident. 40% of our patients were admitted to the ICU, 9% died in the ICU and 22% underwent a neurosurgical intervention.
Long-term motor disturbances were detected in 30% of our cases, cognitive decline in 17% and speech disturbances in 3%. These functional disturbances led to 31% cases of dependency after TBI.

Conclusions
Mild Traumatic Brain Injury in the elderly population causes significant functional disturbances, leading to a high dependency rate. Therefore, the term “Mild”, indicated by the GCS, might not be a good descriptor for TBI cases in the elderly population.

References

(1)Statistics Belgium (2011). Population perspectives 2011 - 2061.www.statbel.fgov.be
(2)Young JS, Hobbs JG, Bailes JE. (2016). The Impact of Traumatic Brain Injury on the Aging Brain. Curr Psychiatry Rep,18(9):81.

Resting-state functional MRI and corpus callosum volumetry in pediatric traumatic brain injury

Dhaval P Shukla

Dhaval P Shukla (NIMHANS)*; Bhagavatula Indira Devi (NIMHANS)

Objectives

To study the resting state functional magnetic resonance imaging rsfMRI and corpus callosum volumetry in children with traumatic brain injury (TBI).

Materials and Methods

Fifteen children with mean age ± SD = 12.8, ±4.64 years with moderate to severe TBI and fourteen healthy children with mean age ± SD = 12.92, ±1.50 years participated in the study. Healthy controls were taken from our pre-existing database. All the children were recruited from neurosurgery out-patient department 1.5 to 2 years after TBI. Resting-state fMRI was acquired using a 3T scanner (Skyra, Siemens, Erlangen, Germany). One hundred and eighty volumes of gradient-echo Planer Images (EPI) were obtained using the following EPI parameters: slices=36, slice thickness=4mm (interleaved manner), FOV=192*192 mm, matrix 64*64,TR=3000 ms, TE=35 ms, re-focussing pulse 90 degrees, matrix-256*256*114, voxel size-3*3*4 mm. T1 MPRAGE acquired for anatomical information with voxel size 1*1*1 mm, 192*192*256 matrix for better registration and overlay of brain activity. FMRIB software library (FSL, http://www.fmrib.ox.ac.uk/fsl) was used to analyse the resting-state data. Corpus callosum volumetry was done with the help of C8 software, which is based on the SPM platform. Clinical outcome was assessed using pediatric Glasgow coma scale.

Results

All children had good recovery at 1.5 to 2 years after TBI. In rsfMRI, the activation in the precuneus-posterior cingulum zone was just half that in healthy controls, and close to two-thirds in angular gyrus as compared to that in healthy controls. The medial prefrontal activation was not picked up in children with TBI. In corpus callosum volumetry analyses, an independent t-test revealed statistically significant changes in the volume of segment II (premotor/supplementary motor area), III (primary motor) and V (parietal-occipital).

Discussion

There is a decreased activity in all the nodes of default mode network (DMN) in the pediatric TBI cohort. Alterations in the activity of DMN in TBI has been previously

described in many studies. It has been shown that reduced activity in the posterior DMN region correlated with neurocognitive dysfunction.

Calcified chronic subdural hematoma – Case report and literature review

Leticia Novak Crestani

Leticia Novak Crestani (UniCesumar)*; Letícia LA Adrielle (Federal University of Sergipe); Gabriela Fe Kalkmann (Federal University of Paraná); Isabela Prado (Federal University of Paraná); Carlos Pereira (Surgical Hospital Charitable Foundation of Sergipe); Nícollas Rabelo (Atenas University Center)

Introduction

Calcified chronic subdural hematoma (CCSDH) represents a rare disease, accounting for only 0.3-2.7% of all chronic subdural hematomas, which may occur secondarily to trauma, subdural effusion, meningitis, or as a complication of chronic shunting for hydrocephalus. The majority of patients with CCSDH are asymptomatic, although the clinical presentation may be characterized by a slow progression of neurological signs and symptoms.

Methods

We report two cases of CCSDH; a woman of 38 years old with clinical diagnosis of rhinosinusitis, and a man of 56 years-old presenting with chronic headache, who were submitted to radiological examinations and was evidenced subdural collection calcified. These patients were treated conservatively because they had no neurological changes and no significant symptoms.

Results

Although chronic subdural hematoma (CSH) is a well-known disease entity and common, CCSH is quite rare. Calcification can occur unilaterally or bilaterally, in small or large dimensions. However, when calcification is extensive, bilateral and involves the entire hemisphere, this condition is referred to as “armored brain” given the appearance of an encased brain. The clinical presentation of patients with CCSDH is characterized by a slow progression of neurological signs and symptoms. CCSH has been observed as the late complication of head injury or new squeal of post meningitis subdural effusion. Pathogenesis of calcification is poorly understood. It is proposed that metabolic and vascular factors may play a role. Vascular thrombosis may have a contributory role. The hematoma may progress gradually from hyalinization to calcification, and finally ossification through irritation of the tissue. After hemorrhage calcification usually takes six months to many years to develop. An indication of the surgery includes features of raised intracranial pressure, headache, or neurological deterioration, although the therapeutic management of the patients should be determined individually. Surgical treatment of CCSDH is based on some techniques, such as twist drill aspiration, burr hole aspiration or microsurgical dissection.

Conclusion

CCSDH are rare entities, which are well tolerated due to their indolent nature even though the radiologic findings might be quite impressive and without direct clinical

correlation. The therapeutic management of the patients should be determined individually.

References

Kanu OO, Igwilo AI, Daini O. Armoured brain: a case of bilateral calcified chronic subdural haematoma complicating infantile hydrocephalus. Romanian Neurosurgery. 2012;XIX; Von, Rokitansky C. Handbuch der pathologischen anatomie. Vol 2. Vienna: Braunmuller und Scidel; 1844; Petraglia AL, Moravan MJ, Jahromi BS. Armored brain: A case report and review of the literature. Surg Neurol Int. 2011 Aug;2:120; Park JS, Son EI, Kim DW, Kim SP. Calcified chronic subdural hematoma associated with intracerebral hematoma:

Digital Therapeutics for Symptoms of Concussive Traumatic Brain Injury in US Military Service Members and Veterans: Developments at the Center for Neuroscience and Regenerative Medicine

Janet B Emery

Emery, JB[1,2], Matheson, LN[3], Shahim, P[4], Cota, M[1,2], Cizza, G[1,2], Chan, L[2,4], & Brody, DL[2,4,5] 1:Henry Jackson Foundation (HJF) 2:Center for Neuroscience and Regenerative Medicine (CNRM) 3:EPIC Neurorehabilitation & Psychology Services, Inc. 4:National Institutes of Health (NIH) 5Uniformed Services University (USU)

Since 2000, nearly 414,000 service members (SMs) have been diagnosed with a TBI. Approximately 83% of these injuries are classified as concussive (cTBI), also known as mild TBI. Three common post-concussive symptoms (PCS) are insomnia, mood disturbances, and post-traumatic headache (PTH). SMs report these symptoms at higher rates than civilians and experience high rates of comorbidity. Cognitive-behavioral therapy (CBT) is one of the most comprehensively studied forms of psychotherapy. The goal of CBT is to reframe dysfunctional thinking patterns and diminish negative emotions and behaviors. Technology provides the opportunity to develop digital therapeutics (DTx) for persistent PCS that can be delivered by smartphone to large populations without a provider. A self-guided DTx could reach patients seeking care outside of the DoD health systems, or who do not have access to in-person therapy. To our knowledge there are no comprehensive, standalone DTx specifically for symptoms associated with cTBI.

Collaboration: CNRM is collaborating with the University of Virginia to test their internet-based CBT for insomnia program Sleep Healthy Using the Internet1 (SHUTi) in a military population. Prior studies of SHUTi have demonstrated similar efficacy to in-person CBT for insomnia.

Development: Depression This DTx is based on the CBT–Depression manual developed by the VA and CBT–TBI manuals, developed by a research team from the University of Washington.

Post-Traumatic Headache The structure of DTx-PTH will be based on the CBT for Chronic Pain manual developed by the VA. Neither primary headache nor PTH are the main focus of this manual, therefore we will rely on subject matter experts who have first-hand experience treating PTH with CBT.

Both programs will incorporate: • Scientific framework to generate and sustain changes in behavior and symptom reduction • Features to maximize compliance and minimize attrition

• Military specific vignettes, designed to increase therapeutic alliance

Using DTx we intend to fill in the gaps where in-person therapy is not an option, rather than reducing access for people who are able to receive in-person treatment. The DoD estimates they would need 20 times the number of therapists they have now to address their current need. This leaves thousands of SMs and veterans left

without treatment. The opinions and assertions expressed herein are those of the author(s) and do not necessarily reflect the official policy or position of USU or DoD.

1. Ritterband LM, Thorndike FP, Gonder-Frederick LA, et al. Efficacy of an Internet-based behavioral intervention for adults with insomnia. Arch Gen Psychiatry. 2009;66(7):692-698.

A Novel Technique for Developing Subject-Specific Brain Finite Element Models

J Sebastian Giudice

J Sebastian Giudice (University of Virginia)*; Ahmed Alshareef (Johns Hopkins University); Taotao Wu (University of Virginia); Christina Gancayco (University of Virginia); Kristen Reynier (University of Virginia); Matthew Panzer (University of Virginia)

Introduction

Finite element (FE) models of the brain are crucial tools for investigating brain biomechanics. However, most studies have utilized models developed using a single, simplified neuroanatomy dataset, which is often chosen to represent the anatomy of a mid-sized male (Giudice et al., 2019). The objective of this study is to develop a technique to rapidly generate subject-specific FE brain models and investigate differences in predicted brain deformation across a cohort of subjects.

Methods

This technique is based on image registration, in which a “moving” image is geometrically aligned with a “fixed” image (Fig. 1). Registration is performed by determining the optimal transformation that maps each voxel in the moving image to the corresponding voxel in the fixed image by minimizing some cost function (Avants et al., 2008). In this study, an anatomical template image (herein referred to as “HBP template”) was constructed from MRI scans obtained from 20 young, healthy males. This template was segmented and transformed into a voxel FE brain model, where each classified voxel was converted into a hexahedral element. Material properties were assigned based on the tissue-classification of each voxel element. The HBP template image was then nonlinearly registered to 44 subjects representing a wide range of neuroanatomies. The resulting registration transformations were applied to the HBP template mesh, resulting in 44 subject-specific brain models. All models were simulated under identical loading conditions using head kinematics from a reconstructed football impact case.

Results

The morphing algorithm was successful in automatically generating subject-specific models with no user intervention. The models accurately represented the subject-specific anatomy, while preserving mesh quality. Across all subjects, intracranial volumes ranged from 1120 – 1750 cm3, with a mean volume of 1470 cm3. The 95th percentile maximum principal strain for the football impact simulation ranged from 0.3 – 0.5 and was generally correlated to overall brain volume. Strain distributions also varied across subjects (Fig. 2). Initial results suggest that strain distribution is dependent on internal neuroanatomical characteristics as well as overall volume. These results suggest that when investigating an individual’s tolerances to brain injury, a brain model using the individual’s specific neuroanatomy is necessary.

Conclusions

Subject-specific model results can be mapped back to either the subject or template image space and be directly correlated to neuroimaging diagnostics for brain injury. They can also be used to identify regions of interest for investigating neurological function following injury. Furthermore, the automated nature of this technique enables future use in the clinical setting as a tool for improving diagnosis, especially when paired with wearable sensor data, and determining optimal surgical interventions.