A Mechanical Platform Design to Study Sport-Related Head Injury

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TCoE

Abstract:

A concussion occurs when the brain impacts the inside of the skull and becomes bruised as the result of a drastic change in acceleration that causes the brain to move. Concussions can occur from any head impact, but they are most often associated with sports. Chronic Traumatic Encephalopathy (CTE) is a neurodegenerative disease that is thought to be the result of a long history of concussions. Symptoms associated with CTE include memory loss, confusion, impaired judgement, depression, and aggression.[1,2] A brain with CTE is also significantly smaller and discolored, as opposed to a normal brain (**Figure 1**). Unfortunately, there is no way to officially diagnose it while the person is alive, so CTE can only be diagnosed through an autopsy. CTE is associated with the presence of defective Tau protein build up in the brain and spinal fluid.

The disease has been seen in brains of individuals who have experienced varying amounts of head impacts, which makes susceptibility to the disease vary from person-to-person. More so than any other sports, head injuries are especially a problem in American football, and as athletes continue to perform at higher and higher levels, the risk of injury increases. Football helmets, which offer protection, are mainly a polycarbonate shell technology that has not changed much since the 1970s. Some companies such as the Seattle start up VICIS have tried to engineer a solution with their Zero1 helmet (**Figure 2**). Rather than being a helmet comprised of a hard shell with little compliance, this helmet design is made to deform with impacts in order to absorb incoming energy.[3] However, new technologies such as this face economic challenges associated with manufacturing, as a single VICIS helmet costs four to five times the standard polycarbonate ones.[4] In this project, we built a mechanical platform with the intention of using it to model the event of an impact in sports, with hopes to use in the future for testing various head protection.

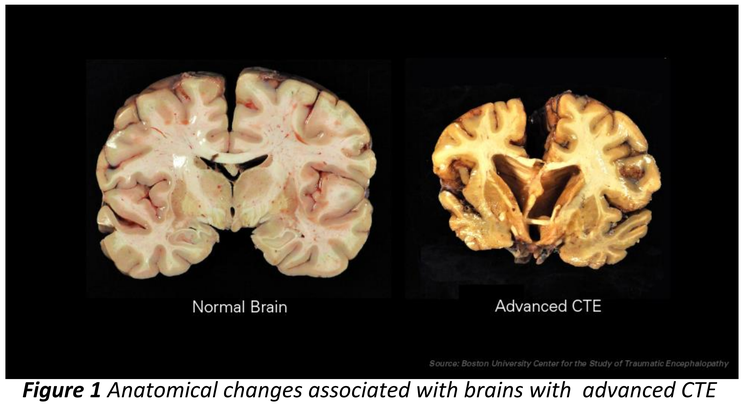

Figure 1 *Anatomical changes associated with brains with advanced CTE*

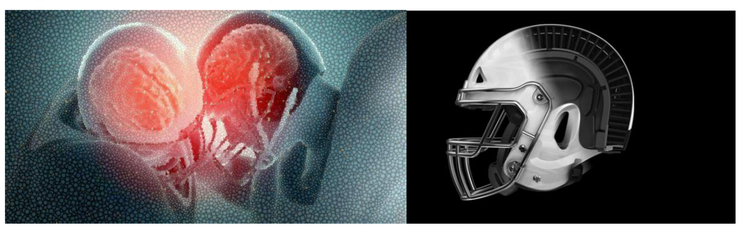

Figure 2: *Compliant helmet design (e.g. Zero1) for improved protection*

Materials and Methods

1. Set certain specifications for the design to adhere to (Mobility, lockable, variable angle of head impact, have minimal friction delivering head to the ground)
2. Design platform using parts files provided (SolidWorks)
3. Order high strength 8020 materials (8020.net)
4. Conduct an IRB approved study aimed at UNH student athletes on the topic of concussion
5. Interview Andrea Harmon, the Head of Sports Medicine at UNH

Platform Design and Prototype

Figure 3 *SolidWorks rendering of platform*

Steel Base Plate

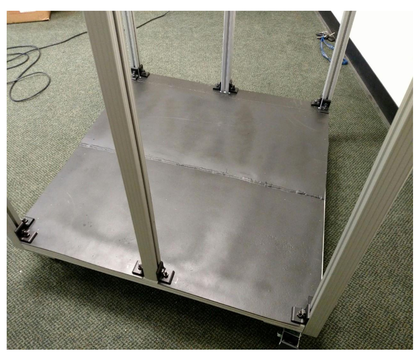

Figure 4 *Platform assembly*

Survey Results:

For the most part, results of the survey came back as expected and a total of 87 responses were obtained. The majority of athletes surveyed (74.12%) have never had a concussion, and unsurprisingly, the vast majority of athletes (95.29%) said that a concussion would not cause them to cease playing their respective sports. The data suggests that survey respondents are, to some extent, aware of the risks involved in their contact sport, and to them the benefits of participation outweighed the risk of a potential concussion although we suspect they will welcome improved protective gear. More surprisingly, two-thirds (66.67%) of athletes surveyed believe what is being done to prevent concussions is sufficient. It makes sense however, since UNH athletics put great emphasis on protection from head injuries This is important, as "The more concussions an athlete suffers, the harder it is for them to recover" said Andrea Harmon, UNH's Head of Sports Medicine said in an interview.[5] Even more surprisingly, only 34.52% of athletes have at least "Some knowledge" regarding CTE. Also many questions remain unanswered; for example how strong is the association between survey results and awareness of CTE? Will increased awareness of CTE-beyond the recorded 34.52% respondents who had some knowledge about the disease- influence the number of respondents (95.29%) who concussion will not influence their decision to participate? Have all of the 4.71% respondents who will reconsider partaking in the sport after concussion had episodes of the injury? And if not does that indicate concussion awareness may be helping create more brain-health conscious players?

Future Work:

We plan to continue working on this project in the coming months, as we did not do everything we originally set out to do. A polymer base plate where the head would impact will be added. If it is possible to acquire a crash test dummy head, it will also be implemented, if not, more economical means of modeling the human head will be explored. With a base plate and dummy head, it becomes possible to test and acquire data.

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