Charasterization of a CCI Model of Traumatic Brain Injury
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Introduction

- Traumatic brain injury (TBI) affects 1.7 million in the U.S annually resulting in a myriad of deficits including impaired learning and memory, increased impulsivity, aggression and mood disorders such as depression and anxiety. [REF]
- Animal models are used to evaluate the effects of TBI and help develop new treatment and preventative measures.
- One of the most commonly used models is Controlled Cortical Impact (CCI), which like all current models suffers from variability in the degree of injury delivered.

This study was designed to:
1) Characterize CCI through the use of high speed imaging and capacitance probe measurements.
2) Develop methods to reduce injury variability and analyze their effectiveness using MRI

Piston Impactor Characterization
- Using the routine metrics of impactor velocity, position and acceleration to produce a moderately-severe TBI in a rat model, CCI impactor tip movement was filmed by high speed imaging at 10,000 frames per second (FPS).
- Impact defined by 5-mm tip traveling at 2.25 m/s to a depth of 3.0 mm in the exposed brain following a craniotomy
- Impactor tip movement was evaluated using Phantom Vision (PV). Data, processed in MATLAB, were based on PV pixel data verified by a capacitance probe with a detection range of 2 mm.

CCI Characterization
- Based on the PV and capacitance probe data, the impactor tip strikes Tissue at a velocity consistently higher (mean 2.8m/s±0.028) than the CCI device setting (2.25m/s).
- The position of the impactor tip does initially penetrate the desired 3mm, but the post impact oscillations result in the tip penetrating deeper into the brain (mean 3.65± .13). The oscillations and high velocity in its movement could be yielding greater injury severity than desired in this model.
- In addition to oscillations, high speed camera evaluation revealed a significant amount of lateral movement in the impactor tip at the point of impact. While evaluation of the magnitude and consistency of these lateral movements is still in progress, these movements could contribute to variations in injury and lesion size detected by MRI.
- In an attempt to mitigate the lateral movement and oscillations of the impactor tip, an agarose gel with a similar density to the rat brain was hypothesized to be a potential solution.

Improving CCI
- TBI was induced in adult Sprague-Dawley rats by CCI as described.
- Oscillations and lateral movement of the piston was buffered by application of 1.5-mm thick, sterile 3% agarose gel plug adhered to the brain after craniotomy.
- 48 hours after injury (with or without agarose gel application) brains were perfused with 4% paraformaldehyde via a transcorial infusion and post-fixed by immersion.
- Rat heads then were evaluated using a 500-MHz magnet at 11.75 T with a gradient recalled echo (3D FLASH) and spin echo Diffusion Tensor Imaging (6 directions)

Results

Conclusions
- Gel buffer had no effect on impact, and the injury appears to be greater in severity.
- Control rat image still being acquired, comparison to be made once data has been collected.
- Further work needs to be done to comprehensively characterize the piston impactor: the lateral movement. Gel work will continue with a greater sample at longer injury times to compare progression and behavioral outcomes between groups to potentially improve the CCI method.

References

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